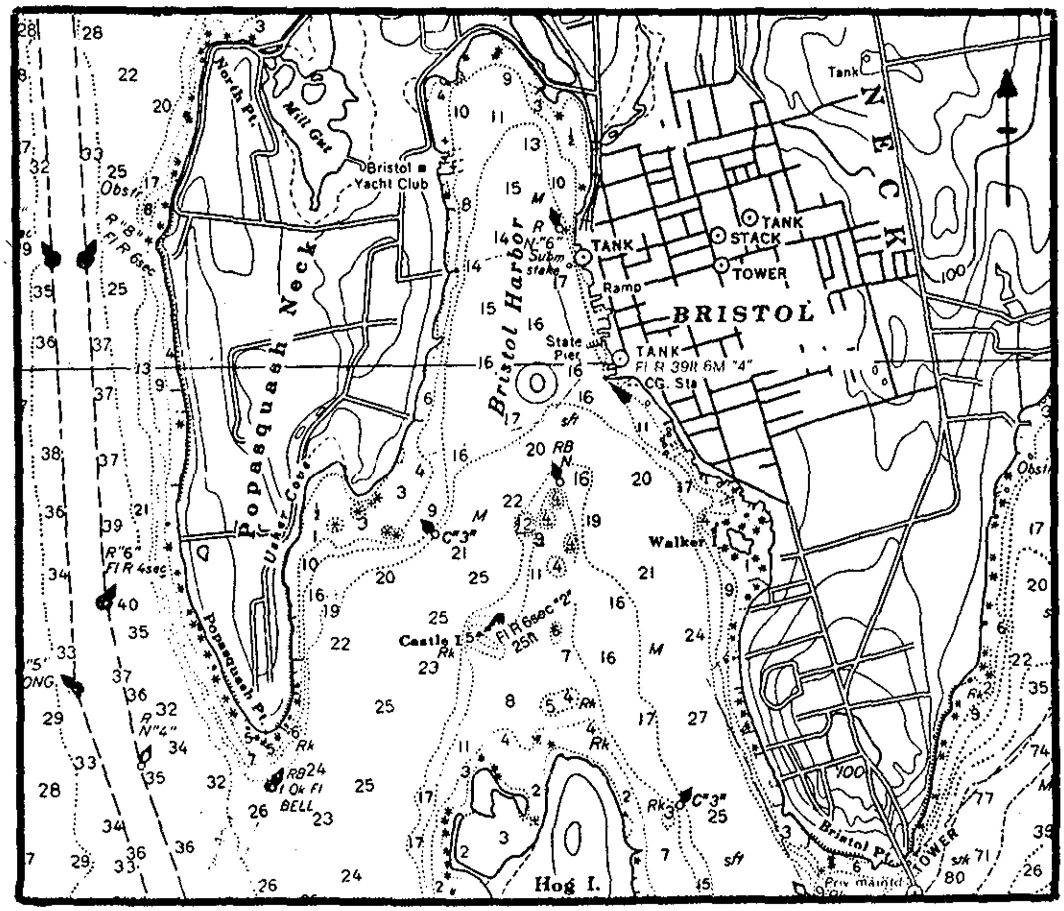
Plan Formulation Report And Environmental Assessment

FILE COPY

Bristol, Rhode Island

BRISTOL HARBOR NAVIGATION IMPROVEMENTS

PHASE 1 AE&D - GENERAL DESIGN MEMORANDUM



NOVEMBER 1981

US Army Corps of Engineers
New England Division

BRISTOL HARBOR, RHODE ISLAND
NAVIGATION IMPROVEMENTS

PHASE I AE&D
GENERAL DESIGN MEMORANDUM
PLAN FORMULATION

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

NOVEMBER 1981

FRONTISPIECE

SYLLABUS

Bristol Harbor is located on the east side of Narragansett Bay, about 13 miles southeast of Providence and 12 miles north of Newport, Rhode Island.

An offshore Federal rock breakwater project was authorized in August 1968 by Congress to protect the harbor from storm waves; however the project was not funded until FY 1979.

The original project was reviewed to determine if the project is still needed; if local interests still desire the breakwater and are willing to participate in the cost of construction; if the location and length of the structure provide the optimum protection; and if the proposed breakwater complies with updated environmental criteria and the Water Resources Council's Principles and Standards. These items are addressed in the report.

Several alternative plans were studied and analyzed to determine the optimum improvement plan to provide for present and future commercial and recreational navigation needs and related activities.

Based on the results of this study, the selected plan of improvement is Plan B, consisting of a 1700-LF offshore, dog-leg, rock breakwater located 300 feet south of the U.S. Coast Guard pier at the east side of the inner harbor. It would have a 1600-foot-wide navigation opening to the west of the breakwater and a 400-foot-wide water circulation opening to the east of the breakwater.

The selected plan is economically justified. The first cost is $5,831,000. Based on the ratio of the general and local benefits accruing to the proposed project, the Corps of Engineers cost would be 65 percent or $3,790,150 and the non-Federal cost would be 35 percent or $2,040,850. The U.S. Coast Guard cost for navigational aids would be an additional $6,500, for a total project cost of $5,837,500. Annual benefits would be $772,000 and annual charges would be $251,000, resulting in a favorable benefit-cost ratio of 3.08 to 1.0.

Maintenance of the proposed project would be a Federal responsibility, contingent upon the availability of future navigational maintenance funds, the continuing justification of the project, and the environmental acceptability of required maintenance activities.

The Division Engineer recommends that the rock breakwater authorized by the 1968 River and Harbor Act for Bristol Harbor be constructed in accordance with the modifications described in Plan B of this report, subject to the conditions of non-Federal (local) cooperation.

BRISTOL HARBOR, RHODE ISLAND
NAVIGATION IMPROVEMENTS
PHASE I AE&D GENERAL DESIGN MEMORANDUM
PLAN FORMULATION

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INTRODUCTION

Bristol Harbor, as shown on Plate 1, is located on the east side of Narragansett Bay about 13 miles southeast of Providence, Rhode Island. It is 2 miles long in a north-south direction and varies in width from 1.3 miles at the mouth to 0.4 miles at its head. Natural depths of 10 to 17 feet exist throughout most of the harbor.

The early history of Bristol is associated with the King Philip Indian War (1676). King Philip maintained a headquarters and plotted his campaign against the white settlers within Bristol's boundaries.

Bristol was first incorporated as a part of the Plymouth Colony in Massachusetts in 1680. Under Royal decree, it was transferred to Rhode Island in 1746. Sailing and shipbuilding played an important role in the life of Bristol during the 17th and 18th centuries. Shipping steadily declined with the advent of railroads and trucking. The harbor is now used extensively by recreational boating craft, commercial shellfishermen and a ferry service to Hog and Prudence Islands. The U.S.C.G. Buoy Station is located on the east shore of the mouth of the harbor.

There are no existing Federal or local navigation improvements in the Harbor. At a public meeting on December 11, 1957, the only improvement desired by local interests was a breakwater to protect the harbor and the commercial/industrial waterfront from southerly storms. In 1966, a Federal navigation improvement project, consisting of an offshore rock breakwater, was recommended at the mouth of the harbor. Since then, there have been increased demands to provide protection for recreational boat anchorages, marinas, launching ramps, and smaller commercial shellfish boats as well as shoreline docks and facilities.

STUDY AUTHORITY

The Bristol Harbor navigation improvement project, recommended in 1966, was subsequently authorized by Section 101 of the 1968 River and Harbor Act (Public Law 90-483), on August 13, 1968, but was unfunded at that time. The authorized project, as described in H.D. 174, 90th Congress, 1st Session, provided for construction of an offshore rock breakwater, the easterly end of which would begin about 400 feet west of the Coast Guard pier and run in a generally west-northwest direction for a distance of 1600 feet (see Plan A on Plate 2).

Funds to begin the Advanced Engineering and Design (AE&D) phase of the authorized project were appropriated by Congress for FY 1979 (starting 1 October 1978). Upon receiving the funds, the Phase I AE&D General Design Memorandum was initiated.

SCOPE OF STUDY

The scope of the study is to reaffirm the results of the original study and the authorized rock breakwater project, or reformulate the project if major changes are required to fulfill the project purposes.

The Board of Engineers for Rivers and Harbors (BERH) was concerned about the alignment of the originally authorized breakwater and recommended that further studies be made to optimize the siting and to maximize the benefits. The U.S. Coast Guard was concerned about silting and maneuvering in the east opening between the breakwater and the Coast Guard pier. Local interests were concerned about their share of the project cost and feasibility of developing the harbor for commercial fishing to revitalize the economy of the town and provide needed additional jobs.

The Division Engineer recommended that the Phase I AE&D Study address the areas of concern, apply environmental and Water Resources Principles and Standards criteria and include an environmental assessment for the considered alternatives.

The study was limited to the development of alternatives which optimize the breakwater length, size and siting, as well as address nonstructural measures that could also prevent damages, increase boating use and enhance the national objectives of National Economic Development (NED) and Environmental Quality (EQ).

STUDY PARTICIPANTS & COOPERATION

The study participants consisted of town officials, the harbormaster, commercial fishermen, members of the Bristol Yacht Club and the Bristol Marine Boat Yard manager, who contributed information on the problems, damages, desires and needs for navigation improvement in the harbor area. A public notice announcing the initiation of the Phase I General Design Memorandum study for navigation improvements in Bristol Harbor was released on 14 February 1979. An informal meeting was held in the Bristol Town Hall on 16 February 1979, with town officials, the harbormaster, representatives from the Rhode Island Coastal Zone Management Council,

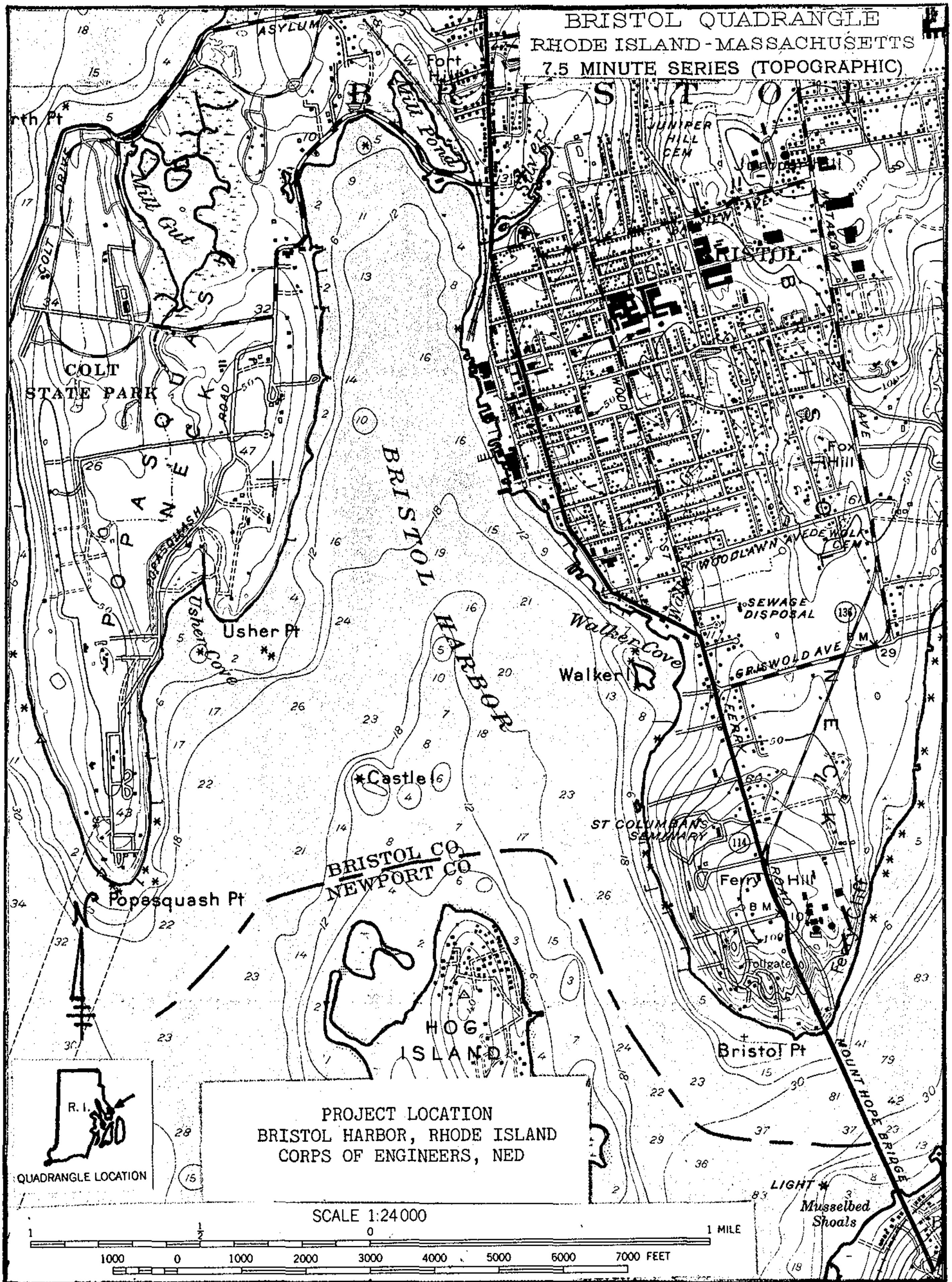

BRISTOL QUADRANGLE
RHODE ISLAND-MASSACHUSETTS
7.5 MINUTE SERIES (TOPOGRAPHIC)
PROJECT LOCATION
BRISTOL HARBOR, RHODE ISLAND
CORPS OF ENGINEERS, NED
QUADRANGLE LOCATION
R. I.
SCALE 1:24 000
1 MILE
7000 FEET
BRISTOL HARBOR
COLT STATE PARK
POPPASQUASH NECK
Usher Pt
Usher Cove
Popasquash Pt
Castle
HOG ISLAND
BRISTOL CO
NEWPORT CO
Walker I
Walker Cove
BRISTOL
Mill Gut
Mill Pond
Fort
ASYLUM
JUNIPER HILL CEM
SEWAGE DISPOSAL
GRISWOLD AVE
WOODLAWN AVE
ST COLUMBANS SEMINARY
Ferry Hill
Fox Hill
Tollgate
Bristol Pt
MOUNT HOPE BRIDGE
LIGHT
Musselbed Shoals

PLATE 1

U.S. Fish and Wildlife Service, National Marine Fisheries Service, Rhode Island Fish and Wildlife and concerned individuals, to discuss the overall authorized project and the Phase I study as well as to determine if local interests still desired a rock breakwater and/or other improvements in Bristol Harbor. The study was also coordinated with other concerned Federal, State and local agencies.

OTHER STUDIES

Bristol Harbor has been the subject of five navigation studies, all by the New England Division. The first of two unpublished reports was completed in December 1925 and considered deepening the harbor to 30 feet. It was found that the existing depths were adequate for present and anticipated future use.

The second report was completed in December 1927 and considered the removal of the remains of a rock-filled turning pier that was deemed a navigation hazard in the harbor. It was found that marking the obstruction would be adequate to protect navigation and removal was not warranted.

The third report was a Survey Report (Review of Reports) on Bristol Harbor, dated December 1966 (Revised March 1967). The report recommended the construction of the 1600-foot offshore rock breakwater. However no Environmental Impact Study was required for the study at the time.

The fourth report was House Document No. 174, 90th Congress, 1st Session, dated 1967, which is the authorizing document for the 1600-foot rock breakwater.

The fifth report was the Phase I AE&D Plan of Study, dated December 1979. The report addressed controversial areas of concern of the Board of Engineers for Rivers and Harbors (BERH), which generally concurred with the recommendations of the Survey Report completed in 1966. However, they felt that the breakwater was not located in the most optimum position and recommended that additional studies be made prior to construction to determine the optimum siting, size, and environmental effects, so as to best provide for all the needs of the harbor. The First Coast Guard District, Boston, Massachusetts expressed concern about the effect of the offshore breakwater on maneuvering their buoy tender and other craft at their existing pier, as well as the possibility of increasing siltation. Local interests were concerned about the lack of sufficient protection to the commercial and industrial wharf area, north of the east gap. The report also described the objectives, the Phase I AE&D study procedures, and provided a planning schedule.

THE REPORT AND STUDY PROCESS

This Phase I General Design Memorandum - Plan Formulation Stage - identifies any changes in technology, physical conditions, public attitudes, national and local priorities and needs, environmental impacts and effects etc., which took place during the time interval between the preauthorization study (July 1955), authorization of the project (August 1968) and funding of the Phase I GDM (October 1978), and which might result in major deviations from the authorized project. In order to minimize long delays in approval of major changes and avoid committing large amounts of resources to a completely modified plan, which has not been approved by Congress, the General Design Memorandum is normally submitted in two phases. The first phase, plan formulation, makes it possible to proceed to the next phase on a more sound basis. The second phase, project design, covers a higher order of project-oriented planning which can only be performed after the specific plan and type of project have been confirmed in the first phase.

PROBLEM IDENTIFICATION

This section identifies the problems and needs of Bristol Harbor that are evident from examination of base conditions, coordination with local interests, consideration of national objectives, interests of the Federal Government and the projection of the most probable future if there is no Federal participation. Once the problems and needs of the study area are identified, planning constraints and their impact on possible management measures designed to solve the problems and needs are also identified and considered. The final activity under problem identification consists of identification of the opportunities of providing harbor protection.

The problems in Bristol Harbor are related to storm driven waves from the southwesterly and southeasterly quadrants of Narragansett Bay. The stronger the winds and the longer it blows, the worse the conditions. The primary problems are a lack of protected anchorages and a need for additional recreational boat facilities; however, the open exposure of the harbor precludes additional open moorings and marina-type boat slips. In addition, docks and piers along the easterly commercial/industrial area and westerly shoreline are subjected to continual damages from waves.

NATIONAL OBJECTIVES

Planning for navigational improvements in Bristol Harbor is based on the national objectives of National Economic Development (NED) and enhancement of Environmental Quality (EQ), as revised in September 1980 by the National Water Resources Council in Principles and Standards for Planning Water and Related Land Resources. The purpose of the Principles and Standards is to promote the quality of life by planning for equal attainment of the two national objectives, which are described as follows:

1. National Economic Development (NED). Maintaining or increasing the value of the nation's output of goods and services as well as improving national economic efficiency which may be achieved through the development of land and water-related resources. In accordance with this objective, present and projected navigation needs are assessed as well as other related elements of land and water resources development. Annual costs are compared against annual benefits in the interest of selecting a project based on national economic development.

2. Environmental Quality (EQ). The preservation and enhancement of the nation's environmental resources is essential to insure their availability for future use. The preservation of natural and cultural areas, creation or restoration of scenic areas, preservation and enhancement of recreational areas, and the rehabilitation and protection of aesthetic values are fully

considered. In accordance with the National Environmental Policy Act of 1969, all available means are utilized to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations.

EXISTING CONDITIONS

There are no existing Federal or non-Federal navigation improvements in Bristol Harbor. It has adequate depths ranging from 10 to 17 feet and is marked with U.S. Coast Guard navigation aids.

Because of its favorable location in Narragansett Bay and proximity to the Providence Metropolitan area, it is intensively used as a base for sport-fishing boats and moderate size recreational sailing craft. There are approximately 250 recreational boat moorings along the northwesterly side of the harbor, which are mostly maintained by the Bristol Yacht Club and the Bristol Marine Boat Yard. There has been practically no change in the number of moorings in the last 10 years.

The recreational boating fleet is very active and consists of about 70 percent powerboats and 30 percent sailboats. A substantial number of the cruising sailboats are in the 25- to 40-foot size and range in value from $25,000 to $90,000. Although the number of moorings has remained about the same, the trend is to replace motorboats with sailboats, due to the increasing costs of gasoline and diesel fuels.

A large number of small shellfish boats, (14- to 20-foot outboards) use the harbor as a base of operations and sell their catch to local dealers. Shellfishing activity increases two to three fold during the summer months, when students and other shellfishermen join the fleet. Some of the boats are moored in unprotected areas of the harbor, and a large number are trailered to the harbor daily.

The Prudence Island Ferry, which provides service to Prudence and Hog Islands, and the U.S. Coast Guard vessels, add to the overall general use and activity in the harbor.

There are no floating marina-type facilities in Bristol Harbor. The town marina at the end of Church Street consists of a small number of deteriorating fixed timber docks and provides limited space for seasonal and transient boats.

The unimproved boat launching ramp at Independence Park, at the north-eastern end of the harbor, is extensively used by local and transient boaters, weather permitting, particularly during the fishing season.

The harbor is landlocked on three sides, but is exposed to the south. Present use of the harbor becomes difficult whenever winds in excess of 12 miles per hour occur, as passage to and from the moored boats by dinghy is hazardous. Use of the harbor is severely hampered whenever winds of over 20 to 25 miles per hour occur from southerly directions, due to waves generated by the wind, and considerable damages occur annually to boats when their moorings break during the high winds. Storm driven waves also damage the wharfs and piers along the east shore of the harbor.

The open exposure of the harbor reduces the recreational boating season from an average of 170 days, which is enjoyed in other areas throughout Narragansett Bay, to 150 days, as well as prohibits aucilliary shoreline development in the commercial/industrial area along the east shore.

No existing endangered or threatened species have been identified in the study area.

CONDITIONS IF NO FEDERAL ACTION TAKEN

If the proposed breakwater is not completed, the present navigation problems associated with southerly waves can be expected to continue. The present low recreational boating growth will probably decrease further and shoreline damages will continue. The opportunity to provide environmental quality enhancement and additional economic stimulation to the locality from new facilities will not be realized.

PROBLEMS, NEEDS AND OPPORTUNITIES

A large number of local shellfishermen unload their catch at the Gilbert and Quitos Seafood Company docks, located on the east shore, north of the State pier and ferry landing. During southerly winds, unloading their catch from 14-foot to 20-foot outboard motor boats becomes very difficult, as well as dangerous. At times the shellfish have to be unloaded at other docks or ports and trucked to the shellfish companies. Outboard motor-boats have been heavily damaged or sunk while unloading or tied up at Gilberts dock. There was also a 50-foot boat which sank at Gilbert's dock during a heavy storm in 1975. There is a need to provide protection for the smaller shellfishing boats from southerly storms.

The southerly exposure also reduces recreational boating activity in the harbor. The problems experienced by the recreational fleet under present degrees of wave conditions discourage full potential use, partly because of the difficulty in mooring and unmooring during periods of moderate to somewhat stronger winds, or in going to and from the anchored boats in smaller craft and dinghys. The accumulated effect of these various problems restricts the use of the fleet to about a 150-day season, compared to an average of a 170-day season in other areas of Narranganset Bay. In addition, transient visits to the Bristol Yacht Club and Bristol

Marine Boat Yard are curtailed when southerly winds are forecast. Local interests feel a breakwater is needed to provide both protection to the existing recreational boating fleet and the opportunity for future expansion.

With the trend to trailered boats, which is partly due to a lack of protected anchorages within the harbor, the town boat-launching ramp at Independence Park is heavily used. During southerly winds the waves in the harbor cause surging conditions at the ramp and it becomes difficult and time consuming to launch and retrieve boats.

Under storm conditions, the municipally owned docks and piers receive varying degrees of damage. An annual budget of $2,000 is allocated to the harbormaster for repairs of the docks. Other shore structures at Gilberts, Quitos and the Bristol Yacht Club suffer periodic damages, and shoreline erosion occurs at the head of the harbor.

The wave conditions within the harbor at the Bristol Yacht Club preclude standard marina-type slips and most of their sailing fleet is forced to anchor offshore at moorings. If harbor protection is provided, the yacht club would have the opportunity to construct a system of boat slips to accommodate a large portion of their fleet and reduce the hazards associated with offshore moorings.

The U.S. Coast Guard Buoy Depot is located on the east shore, at the southernmost terminus of the commercial and industrial section of the harbor area. The outer end of the pier is constructed of timber piles and a concrete deck. The southerly side of the pier is used by larger Coast Guard boats up to 180 feet long, and the northerly side of the pier is used by smaller work boats and patrol boats. Significant wave heights of 4 feet are generated from the south, pass under the pier, and reflect off the vertical granite pier located at the Elks Home, adjacent to and north of the Coast Guard pier, thereby causing increased wave damages and hazardous conditions along that side of the pier.

The Prudence Island Ferry, located just north of the Armory at Church Street Dock, transports freight and passengers to Hog Island and Prudence Island. It is the main line of support for both islands. Southerly waves strike the ferry broadside as it docks or departs, making the approach hazardous.

The Elks Club dock was destroyed by Hurricane Carol in August 1954 and never replaced. However, members of the club have indicated that the dock would be replaced if some kind of harbor protection is provided.

The dock at the Castle Restaurant, at the head of the Harbor, was destroyed in the "Great Blizzard of 78." The owner said boating patrons used the dock while dining and he would replace it if harbor protection is provided.

Some type of harbor protection is needed to protect the existing boating fleets and shore structures, provide an opportunity to develop aditional recreational boating facilities at the town-operated Independence Park and other areas within the harbor, encourage future commercial facilities, and preserve and enhance the environmental aspects of the harbor.

PLANNING CONSTRAINTS

Lands, easements and/or rights-of-way may not be available for construction and subsequent maintenance of land constructed breakwaters. The size of protective improvements and the amount and nature of the non-Federal financial commitment could limit the towns participation in the construction of the selected improvement. Lack of an approved ocean dumping site at the time of construction may require a more expensive and less environmentally acceptable site. Both shorelines are on the National Historic Register and any alternative breakwater plans requiring alterations of the shoreline must comply with their requirements. Maneuvering and berthing space on the south side of the Coast Guard pier must be maintained and alternative plans cannot encroach into the space.

PROBLEM AND OPPORTUNITY STATEMENTS

The objectives of providing navigation improvements at the mouth of Bristol Harbor are to eliminate the problems associated with the existing navigation conditions, provide the opportunities for environmental quality enhancement, enable local interests and others to provide additional navigational facilities, and safely utilize the existing resources in the area.

Providing improvements offers the following specific opportunities:

- Contribution to the protection of the existing recreational boating fleet in Bristol Harbor, as well as boats that will utilize the harbor between 1983 and 2033.

- Contribution to the safety of commercial shellfishermen and maneuvering of the ferry during stormy periods along the commercial and industrial areas of the harbor between 1983 and 2033.

- Contribution to the prevention of damages to the pier and boats at the U.S. Coast Guard Depot, as well as providing for future protected dockage area behind the breakwater for larger boats for a period of fifty years.

- Contribution to the reduction of damages to the existing commercial and industrial wharves and piers within the harbor for the life of the project up to the year 2033.

- Contribution to reducing wave heights and boarding hazards within the harbor at the Yacht Club and town launching ramp, and enhancing the opportunity to construct future marina-type floating ships between 1983 and 2033.

- Contribution to the opportunity to replace former docks at the Castle Restaurant and Elks Club, within protected waters, after the breakwater is completed, between 1983 and 2033.

FORMULATION OF PRELIMINARY PLANS

In determining the preliminary plans for the protection of Bristol Harbor for navigation purposes, consideration was given to prior plans of improvement, the concerns of Federal, State and municipal agencies and desires of commercial and recreational users of the harbor. Fixed and floating breakwater structures along alternative alignments and other management measures to mitigate damages were thoroughly investigated. In formulating these plans and management measures, meetings and field visits were held with Federal, State and local agencies as well as concerned individuals. A public meeting was held in Bristol on 21 August 1980 to solicit the overall views of the general public. The most feasible alternative plans were developed to conform with the WRC Principles and Standards policies. Both structural and nonstructural alternatives were given equal consideration in formulating the preliminary plans.

MANAGEMENT MEASURES

Management measures are the various methods of resolving the problems and needs in the study area. In this study, structural methods are physical structures designed to reduce wave action from entering Bristol Harbor. Nonstructural methods are those means by which shoreline owners and boat owners can reduce the effects of the wave action within their areas of concern.

PLAN FORMULATION RATIONALE

The formulation of plans of improvement for Bristol Harbor was predicated on the needs and desires expressed by users of the waterway. Each alternative was considered on the basis of its contribution to the desired protection to both the existing and future recreational and commercial fleets and shoreline structures.

Selection of a specific plan for Bristol Harbor is based on technical, economic, and environmental criteria that permit a reasonable and objective appraisal of the impacts and feasibility of the alternative solutions.

Technical criteria require that the optimum plan should provide the desired protection from storm-induced damages and should minimize interference with normal navigation.

Economic criteria specify that tangible benefits should exceed economic costs and that the scope of the project provide maximum net benefits.

Environmental criteria involve utilizing available sources of expertise to identify endangered species of marine life. Furthermore, effects on natural resources as well as adverse social impacts should be minimized. Environmental criteria require that activities attracted to the area after plan implementation should be consistent wth activities of the surrounding area and that said activities be environmentally acceptable. The selected plan should incorporate measures to preserve and protect the environmental quality of the project area. Finally, both plan formulation and implementation should be coordinated with interested Federal and non-Federal agencies, local groups, and individuals through cooperative efforts, conferences, public meetings, and other procedures.

PLANS OF OTHERS

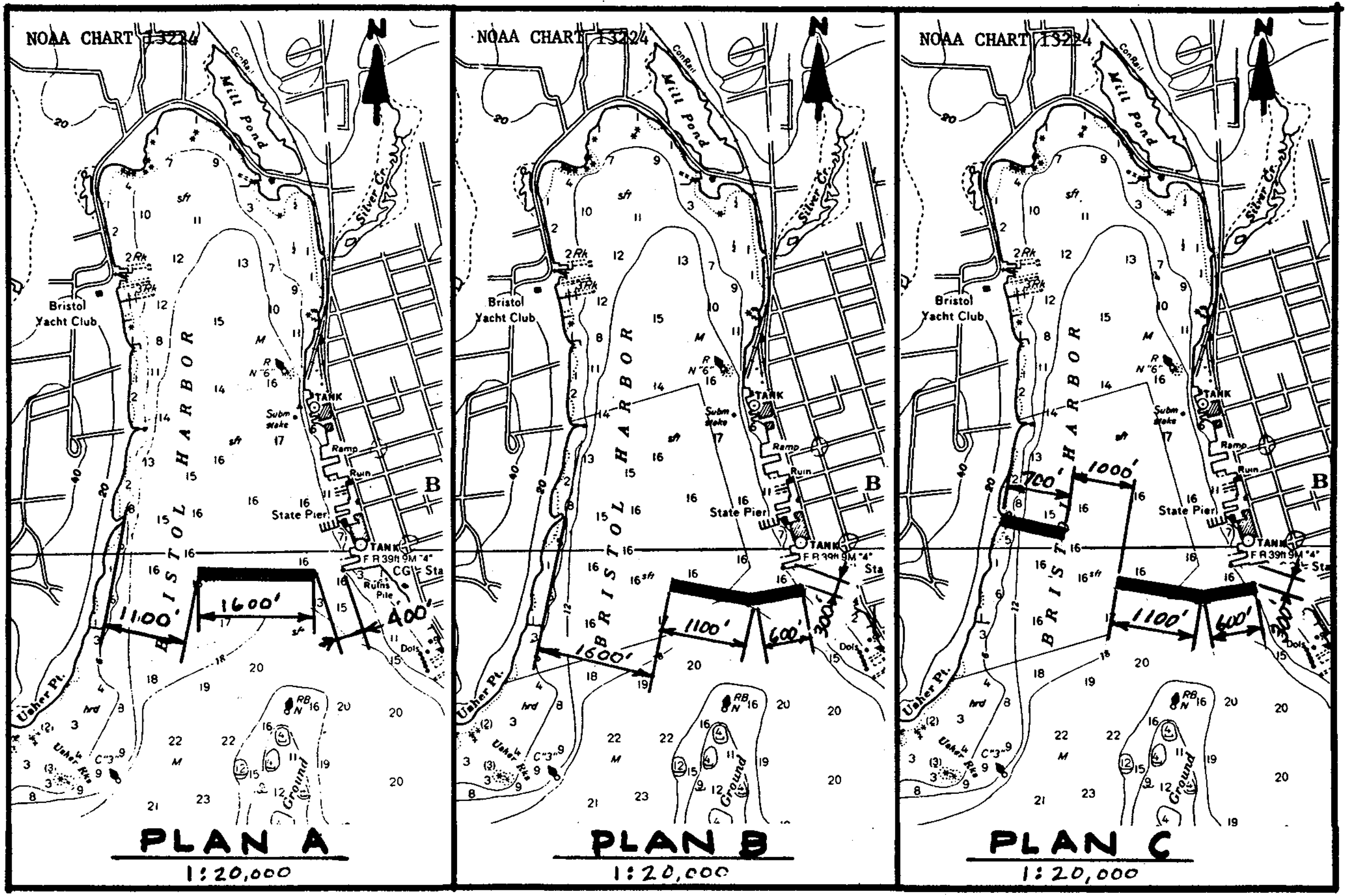
The rock breakwater authorized in 1968 for Bristol Harbor is the only Federal plan that has been developed for the protection of the harbor. There are no other Federal or local navigation projects or plans for navigation improvements for Bristol Harbor, except for navigational aides maintained by the United States Coast Guard.

ANALYSIS OF PLANS CONSIDERED IN PRELIMINARY PLANNING

The plans considered in preliminary planning varied in the alignment, cost of implementation, degree of protection and opportunities afforded for present and future growth and development.

The plans included fixed and floating breakwaters, a hurricane barrier and individual methods to reduce boat and shoreline damages. The plans were not fully developed, but only studied in enough detail to analyze and justify the original authorized plan or to reformulate an optimum plan to be recommended for the next level of study.

The major structural plans considered were three offshore rock breakwaters, designated as Plans A, B and C, shown on Plate 2, and a hurricane barrier designated as Plan D and floating breakwaters designated as Plan E, shown on Plate 3. Nonstructural plans included improved moorings and transfer of boats, repair or removal of shoreline structures, flood insurance and zoning.



BRISTOL HARBOR RHODE ISLAND
ALTERNATIVE ROCK BREAKWATER PLANS
CORPS OF ENGINEERS, NED

PLATE 2

DESCRIPTION OF PLANS

Descriptions of the considered alternative structural and nonstructural plans are as follows:

A. Structural Alternatives

Three basic permanent breakwater configurations were developed for this study. Plan A is the originally authorized plan for the protection of Bristol Harbor. Plans B and C were developed in response to the recommendation of the Board of Engineers for Rivers and Harbors to make additional studies prior to construction of the breakwater to determine the optimum siting, size, and environmental effects, so as to best provide for all of the needs of the harbor. Two other structures were also analyzed.

1. Plan A

A rock breakwater 1,600 feet long with a top width of 10 feet at elevation 10 feet above mean low water, beginning at a point 400 feet west of the Coast Guard Pier and extending in a northwesterly direction. A 1,100-foot opening would remain on the west side of the harbor.

2. Plan B

A rock breakwater of the same width and top elevation as in Plan A but beginning at a point 300 feet south of the Coast Guard pier and 400 feet from the shoreline, and extending 600 feet west, then 1,100 feet on a dog-leg to the northwest. This configuration would allow a 1,600-foot opening on the west side of the harbor. The orientation of the breakwater in this proposal would provide protection for the entire commercial and industrial area on the eastern shore and the U.S. Coast Guard pier.

3. Plan C

A rock breakwater on the east side of the harbor as described in Plan B above, as well as an additional rock breakwater extending 700 feet in a southwesterly direction from the western shore of the harbor. The two structures in this alternative would also protect some of the private moorings along the western shore of the harbor. The alignments of the alternative rock breakwater plans are shown on Plate 2.

4. Plan D - Hurricane Barrier

A hurricane barrier at the head of Bristol Harbor was investigated as a result of inquiries from local officials as to the feasibility of constructing such a structure to protect the entire recreational and commercial fleets and the shoreline within the harbor from storm-induced waves and periodic hurricane damages to the commercial and industrial area along the easterly shore.

The hurricane barrier would involve construction of a rock structure similar to the breakwaters. It would extend from shore to shore, a distance of about 4,400 feet, with a top elevation of 22 feet above mean low water and side slopes of 1.5 to 1.0. The hurricane barrier would have a gated opening for normal navigation purposes and would be closed during hurricanes. Sluice gates on either side of the navigation opening would reduce tidal currents during normal periods. An earth dike would be required at Mill Gut at the northwest side of the harbor to prevent "back-door" flooding.

5. Plan E - Floating Breakwater

Concrete floating breakwaters were examined as a possible economic alternative to a rock breakwater for Bristol Harbor. A breakwater of this type would consist of floating concrete blocks filled with styrofoam. Each block would be approximately 15 feet long by 5 feet deep by 3 feet wide. These blocks, connected with bolts and rods into an open lattice-type configuration, would be assembled into 60-foot by 39-foot modules. The modules would then be connected end to end to form the length of breakwater desired. The whole structure would be anchored with heavy chains and 25-ton anchors on each side. This type of floating breakwater could be used to protect the whole harbor or only specific areas. Alternative alignments are shown on Plate 3.

B. Nonstructural Alternatives

Nonstructural plans fall into the following five general categories:

1. Reduction of Boat Damages

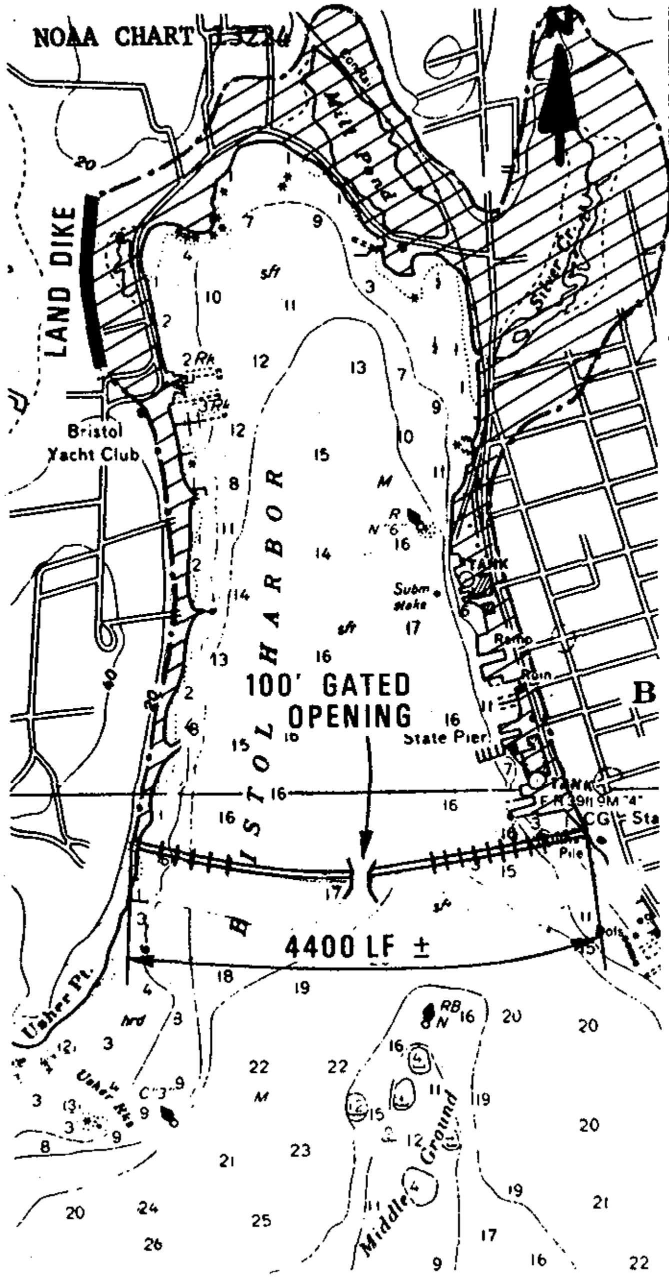
The boat owners could strengthen their individual mooring lines and moorings. In times of approaching rough weather, boats could be either removed from the water or moved to a safer, sheltered harbor.

2. Reduction of Shoreline Damages

Damages to shoreline property could be reduced through a series of repairs and/or modifications to existing docking facilities. Reinforcing or replacing the docks with steel bulkheads or rock revetment is one approach which would strengthen present docking facilities and make them less susceptible to future damages. Removing docks altogether would eliminate a source of deteriorating shoreline damage. Zoning would prohibit construction that would be subsequently damaged by storms.

3. Increase of Recreational Boating Potential

The recreational boating potential of Bristol Harbor could be enhanced by development of facilities that would expand public access and provide more utilization of the harbor. Construction of boat launching ramps separately or in conjunction with dry stacking facilities for boats would expand



LEGEND

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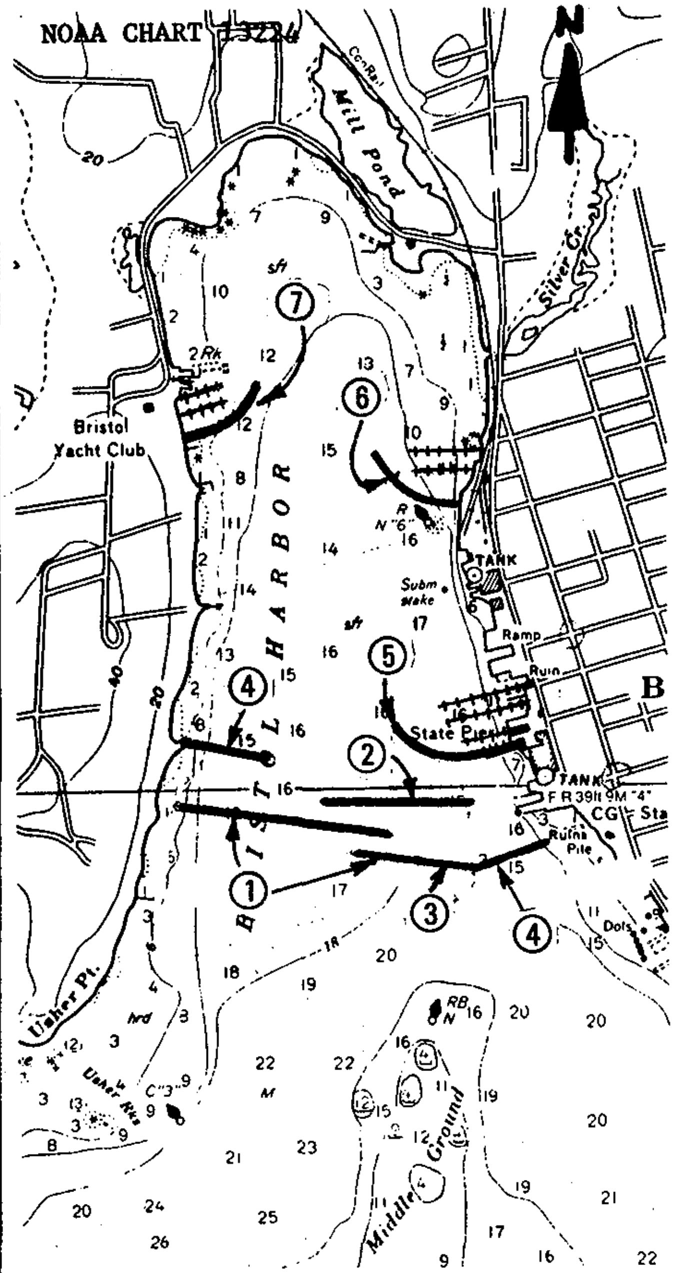
PLAN D

HURRICANE PROTECTION BARRIER

1:20,000



1. FULL HARBOR ALIGNMENT
2. PLAN A BREAKWATER ALIGNMENT
3. PLAN B BREAKWATER ALIGNMENT
4. PLAN C BREAKWATER ALIGNMENT
5. TOWN DOCK ALIGNMENT
6. INDEPENDENCE PARK ALIGNMENT
7. BRISTOL YACHT CLUB ALIGNMENT

PLAN E

FLOATING BREAKWATERS

1:20,000

BRISTOL HARBOR RHODE ISLAND
ALTERNATIVE STRUCTURAL PLANS
CORPS OF ENGINEERS, NED

access to the harbor. Placing a floating breakwater at a launching site would allow launching during marginal weather and provide a sheltered area for additional moorings.

4. Flood Insurance

Coastal flood insurance, sponsored by the Federal Insurance Administration's flood insurance program, is another nonstructural measure that was considered for Bristol Harbor. This approach, however, was found to be nonapplicable to the wave damage problems on the Bristol waterfront. F.I.A. insurance is applicable only to flooding of buildings and their contents and does not cover seawalls, piers or docks.

Although the above measures are categorized as nonstructural, they would require some kind of structural modifications and construction activity. Non-Federal interests would be responsible for the implementation of nonstructural methods, therefore no cost estimates were prepared.

COMPARATIVE ASSESSMENT AND EVALUATION OF PRELIMINARY PLANS

The comparative assessment and evaluation of the considered alternative plans indicate that some of them do not fulfill or comply with planning objectives and provide only limited opportunities for future development and growth of the commercial and recreational boating fleets. The assessment and evaluation of each plan are as follows:

Structural Alternatives

1. Plan A. This originally authorized 1,600 linear-foot rock breakwater would fulfill the planning objectives and protect about 70 acres of the harbor from storm waves. However, it would not protect the U.S. Coast Guard pier and a portion of the commercial/industrial shorefront. Preliminary economic analysis indicated a favorable benefit-cost ratio (BCR) and the plan was selected for further study to determine the optimum plan that would maximize benefits.

2. Plan B. This 1.700 linear-foot dog-leg rock breakwater would provide protection to about 65 acres of the harbor area from storm waves. Although it would protect 5 acres less of the open harbor, it would fully protect the U.S. Coast Guard pier and the commercial/-industrial area along the waterfront. Preliminary cost analysis indicated a favorable BCR and the plan was selected for further study to determine maximized benefits.

3. Plan C. This plan includes Plan B and an additional 700 linear-foot breakwater extending from the west shore for a total of 2,400 linear feet. The plan would protect about 150 acres of the harbor from storm waves. In addition to protecting the Coast Guard pier, and the commercial/industrial area, it would also provide protection to the

Bristol Yacht Club and the Bristol Marine Boat yard. Preliminary economic analysis also indicated a favorable BCR and the plan was selected for further detailed study.

4. Plan D. Hurricane Barrier. The hurricane barrier would provide protection from storm waves for the entire 390 acres of harbor, however, preliminary cost analysis showed that the benefit-cost ratio was considerably below unity and local cost sharing would be beyond the town's capability, therefore this alternative plan was dropped from further consideration.

5. Plan E. Floating Breakwater. The floating breakwater alternatives would provide limited protection to the harbor, due to the fact that the state of the art is limited to a design wave height of 2.5 to 3.0 feet and wave periods of 2.0 to 2.5 seconds. The average design wave for Bristol Harbor is 4.0 feet and 3.5 seconds and a floating breakwater would not provide the desired protection, resulting in large residual damages. High maintenance and replacement costs (replace every 10 years) indicated an unfavorable BCR and the plan was dropped from further consideration. Preliminary benefit-cost comparisons of the considered breakwaters and hurricane barrier are shown in Table 1. Annual benefits include recreational boating benefits, reduced damages to existing boats and reduced damages to shore facilities. Recreational boating benefits are defined as values equal to the net return on the depreciated investment on the boat, after expenses, that owners would receive if they let their boat out for hire, and varies according to the size and type of boat. The recreational boating benefits include the increased use of the existing recreational boating fleet, and benefits for new recreational boats entering the fleet after construction of the breakwater. Commercial fishing benefits were found to be negligible during the initial investigation and were not included in the overall annual benefits for preliminary benefit-cost comparisons. They were, however, subsequently included in the evaluation of the detailed plans described on pages 23 through 28. The full economic analysis is shown in Appendix F.

After the investigation and development of alternative plans of improvement, it was found that during the interval between authorization of the project in 1968 and finding of the Phase I GDM in 1978, local interests still desire and need a protective breakwater for Bristol Harbor. Physical conditions have remained basically the same, but there are some noticable shoreline changes as well as the loss of the Ellis Club and Castle Restaurant docks. Technology has developed "floating breakwaters," but the state of the art precludes use of them in Bristol Harbor.

The town of Bristol is in favor of the authorized breakwater project, and local officials have shown continued support at the public hearing and in subsequent correspondence.

Nonstructural Alternatives.

1. Reduction of Boat Damages. Strengthening of mooring lines, removing boats from the water or moving the boats to a safer sheltered harbor in times of approaching rough weather will not reduce the storm waves in the harbor or provide the opportunity for increased recreational boating or potential commercial fishing growth. Therefore this alternative was not considered for further study.

2. Reduction of Shoreline Damages. Repairing, modifying, replacing or removing existing structures will not provide protection of the harbor from storm waves or contribute to the recreational/commercial growth, therefore, the plan was dropped from further consideration.

3. Increase of Recreational Boating Potential. Construction of boat launching ramps, combined with "dry-stacking" will not protect the harbor from storm waves, and this option was dropped from further consideration.

4. Flood Insurance. Coastal flood insurance is not available for wave damages to seawalls, piers and docks, so it was dropped from further consideration.

CONCLUSIONS

The comparitive assessment and evaluation of the considered plans has resulted in the conclusion that a breakwater structure at the head of the harbor, similar to the breakwater authorized in 1968, would provide protection from southerly storm waves and enhance the environment, as well as provide opportunities for recreational and commercial growth. Therefore, the alternative rock breakwater plans are warranted for further detailed studies.

TABLE 1
PRELIMINARY ROCK BREAKWATER BENEFIT/COST COMPARISONS

	FIRST COST	CORPS & C.G. COST	LOCAL COST	FEDERAL ANNUAL COST	LOCAL ANNUAL COST	ANNUAL(4) BENEFITS	B/C RATIO
PLAN A	$ 5,648,000	$2,834,000	$2,824,000 (50%)	$226,000	$214,000	$489,000	1.11
PLAN B	$ 5,831,000	$3,975,000	$1,865,900 (32%)	$312,00	$141,000	$480,000	1.06
PLAN C	$ 7,911,000	$4,914,800	$3,006,200 (38%)	$389,000	$228,000	$598,000	1.2
PLAN D HURRICANE BARRIER	$31,600,000	$23,700,000*(1)	$1,580,000*(2) $6,320,000*(3) $7,900,000	$1,799,000	$690,000	$898,000	0.36

*President's proposed cost sharing policy for hurricane protection projects.
(1) 75% Federal cost
(2) 5% State cost
(3) 20% Local cost
(4) Commercial benefits not included in preliminary investigation

TABLE 2
PRELIMINARY COMPARISON OF COSTS FOR
CONCRETE FLOATING BREAKWATERS

	LENGTH (FEET)	COST PER L.F.	FIRST COST	PROTECTED AREA (ACRES)	FEDERAL COST	LOCAL COST
FULL HARBOR PROTECTION	3,800	$1,900	$6,840,000	260	$3,420,000	$3,420,000
PLAN A Alignment	1,600	$1,900	$3,040,000	70	$1,520,000	$1,520,000
PLAN B Alignment	1,700	$1,900	$3,230,000	65	$1,615,000	$1,615,000
PLAN C Alignment	2,400	$1,900	$4,560,000	150	$2,280,000	$2,280,000
TOWN DOCK	600	$1,500	$ 900,000	6.2	$ 450,000	$ 450,000
INDEPENDENT PARK	800	$1,500	$1,200,000	11.0	$ 600,000	$ 600,000
BRISTOL YACHT CLUB	800	$1,300	$1,200,000	9.6	$ 0	$1,200,000

ASSESSMENT AND EVALUATION OF DETAILED PLANS

The preliminary screening of alternative plans has resulted in the conclusion that a rubble rock breakwater is the most efficient and practical method to adequately protect Bristol Harbor from southerly wind waves.

The three alternative plans considered for further detailed study are basically variations of a rubble rock breakwater. The variations include differences in length and alignment. Impacts which are common to all three plans are discussed in the following sections. Impacts unique to each plan assessed and evaluated are in subsequent sections.

GENERAL ASSESSMENT AND EVALUATION OF IMPACTS

All three breakwater plans provide a high degree of protection for existing and future commercial and recreational boating interests, as well as shoreline properties, from storm waves originating in Narragansett Bay.

A detailed hydrographic and dispersion mathematical model of Bristol Harbor was performed by Normandeau Associates of Bedford, New Hampshire to determine the effect of the breakwaters on the harbor. The three breakwater plans indicated that the breakwaters each have the same general effect of slightly increasing current speeds in the vicinity of the breakwaters, while not affecting currents in the lower harbor.

Local current eddies are formed north and south of each breakwater, their maximum speeds occurring an hour before and after slack water. Tidal heights are not significantly altered by the breakwater constriction, with an overall range difference of only several centimeters.

Flushing dispersion patterns for Plans A and B are similar to those without a breakwater, while Plan C appears to allow a higher concentration of watermass in the upper harbor during a portion of the tidal cycle.

Bulk chemical and elutriate tests on bottom sediments indicate that the material is suitable for open water or land disposal and that suspended sediment will affect only a small area, on a short-term basis.

The breakwaters would eliminate approximately 4 to 6 acres of bottom habitat. However, this impact will be affected by the breakwaters themselves, which will provide hard surfaces for the attachment of various other invertebrates and habitat for fish, lobster and mussel production.

Construction of a breakwater will impact the existing commercial and recreational use of the harbor.

All the breakwater plans would result in both social and economic impacts to the town of Bristol. Beneficial social impacts would include increased employment. Adverse social impacts would include increased traffic in the general harbor area. Economic impacts would include increased income to fishermen, reduction in boat damages and damages to shorefront property. Secondary economic impacts would include increased tax revenue to Federal, State and local governments through increased employment opportunities.

Construction could be either from land or from barge mounted cranes. A temporary trestle or access road from land would impact the existing highway traffic patterns. Barge mounted cranes and stone-carrying scows would affect the Coast Guard vessels, and commercial and recreational boats to a limited extent.

MITIGATION REQUIREMENTS

In order to mitigate construction impacts, the use of barges to construct the outer breakwater should be suspended or limited during the recreational boating season. Construction from land and transport of materials through the town streets should not be permitted to interfere with busy traffic periods. Any required dredging should be done in the fall or early spring in order to mitigate any conflicts with recreational boats.

IMPLEMENTATION RESPONSIBILITIES

The implementation responsibilities for all three detailed plans would be the same. All costs associated with the initial project construction would be borne by Federal and local interests in accordance with determined cost apportionments. Costs of containment of dredged materials, if required, would be borne by local interests.

COST ALLOCATION AND APPORTIONMENT

All the quantifiable benefits that are resulting from the breakwater construction would be general or local in nature. Costs attributable to general benefits would be 100 percent Federal and costs attributable to local benefits would be 50 percent Federal and 50 percent local.

FEDERAL RESPONSIBILITY

Federal costs for the construction of the breakwater project would be funded and furnished by Congress. The Corps of Engineers would be responsible for the construction and subsequent maintenance of the overall project. The U.S. Coast Guard would provide and maintain navigational aids.

All preauthorized study costs as well as the design and preparation of plans and specifications, and contract administration are Federal responsibilities.

NON-FEDERAL RESPONSIBILITIES

The town of Bristol, Rhode Island, the local sponsor, would be responsible for the operation and maintenance of an adequate public landing for the sale of fuel, lubricants and drinking water, open to all on equal terms, and for providing all necessary lands, easements and rights-of-way for construction and subsequent maintenance of the project, including disposal areas for dredged materials, if required.

The town would also hold the United States free from damages that may result from construction and maintenance of the project. Moreover, the local sponsor would provide and maintain berths and other mooring facilities for local and transient vessels as well as access roads, parking lots and other required public use shore facilities, open and available to all on equal terms. The town would also be required to establish regulations prohibiting the discharge of untreated sewage and other pollutants into the waters of Bristol Harbor.

PLAN EVALUATION - PLAN A

PLAN DESCRIPTION

Plan A would provide for a 1,600-foot rubble rock breakwater with a top width of 10 feet at elevation 10 feet above mean low water and 1-1/2 on 1 side slopes, beginning at a point about 400 feet west of the end of the U.S. Coast Guard pier and extending in a northwesterly direction toward Popasquash Point. A 1,100-foot opening would remain on the west side of the harbor for navigation purposes.

IMPACT ASSESSMENT

Breakwater Impacts. A 1,600-foot breakwater was found to be necessary to provide sufficient area to adequately protect the existing boat fleet and for reasonable expansion of the recreational fleet during the life of the project. Dispersion patterns indicate that this plan will provide adequate flushing and that increases in tidal currents and tide levels would be minimal. The breakwater alignment will not protect the Coast Guard pier or portions of the commercial/industrial area on the east shore from southwesterly or southeasterly waves.

Navigation Impacts. The breakwater will block off the center of the harbor to navigation and the boats will be required to use the 1,100-foot opening to the west or the 400-foot opening to the east of the breakwater. Boats using the east opening could occasionally conflict with Coast Guard usage. This plan would protect 70 acres of the waterway and 490 mooring spaces.

Economic Impacts. Breakwater costs are based on utilizing rock from a local quarry in Tiverton, Rhode Island and ocean disposal of dredged material in Rhode Island Sound, at July 1981 price levels. Annual costs are based on a 3-1/4 percent interest rate, which was mandated at the time of authorization in 1968, and a 7-5/8 percent interest rate (present rate for comparison purposes). Analysis of costs and benefits is shown in Appendix F.

The estimated first cost of Plan A is $5,648,000. A summary of the project economics is as follows:

PLAN - A

Rate	Annual Benefits	Annual Costs	B.C.R.	Net Benefits
3-1/4%	$729,000	$258,000	2.82	$471,000
7-5/8%	$666,000	$455,000	1.46	$211,000

EVALUATION AND TRADEOFF ANALYSIS

Of the three breakwater plans considered, this plan provides protection for the second largest amount of harbor area. However, it leaves the commercial/industrial segment of the harbor and Coast Guard pier unprotected from storm waves from both southerly quadrants. Although the plan will allow adequate flushing, Plan B provides better flushing patterns.

COST APPORTIONMENT

The cost apportionment is based on the ratio of the general and local benefits to the overall benefits, and is as follows:

	3-1/4%	7-5/8%
Federal (General)		
Corps of Engineers 61%/62%	$3,445,280	$3,501,760
U.S. Coast Guard	6,000	6,000
Total Federal	$3,451,280	$3,507,760
Non-Federal (Local)		
Cash Contribution 39%/38%	$2,202,720	$2,146,240
Total Non-Federal	$2,002,720	$2,146,240

PUBLIC VIEWS

Views of Federal Agencies. The U.S. Fish & Wildlife Service estimates that 4.0 acres of quahaug habitat would be lost due to this plan and recommends that all quahaugs be removed from the area prior to construction. The U.S. Coast Guard is concerned about the safe access of their 180-foot buoy tender and suggested that the breakwater be shortened or moved northward away from the clear approach to the pier. In addition the Coast Guard is concerned about the possibility of accretion and silting which might occur, thereby requiring future dredging. The National Marine Fisheries Service recommended that current studies be made to determine if stagnant areas will be developed in the harbor.

Views of Non-Federal Agencies and Others. The Rhode Island Department of Environmental Management is concerned about tidal flushing patterns and accumulation of ice flows.

PLAN B

PLAN DESCRIPTION

This alternative was developed in response to the request of the Board of Engineers for Rivers and Harbors to establish optimum siting and sizing of a protective breakwater to best provide for all the needs of the harbor. The original breakwater was realigned to begin about 400 feet from the east shore and 300 feet south of the Coast Guard pier, to allow the 180-foot Coast Guard buoy tender to safely utilize the southerly berth along the existing pier. The breakwater extends 600 feet in a westerly direction and dog-legs to the northwest for a distance of 1,100 feet, for a total length of 1,700 feet.

IMPACT ASSESSMENT

Breakwater Impacts. This alignment would provide protection for the entire commercial/industrial area of the shoreline, as well as the Coast Guard pier. Current and dispersion mathematical modeling indicates that increases in tidal currents and tide levels would be minimal, and flushing patterns are better for this plan than Plans A or C.

Navigation Impacts. A 1,600-foot opening on the west side of the breakwater would remain for navigation use. However, the 400-foot opening on the east could also be used by smaller craft. This plan would protect 65 acres of waterway and 455 new mooring spaces.

Economic Impacts. The estimated first cost of Plan B is $5,831,000. Complete analysis of costs and benefits are shown in Appendix F. A summary of the project economics is as follows:

PLAN - B

Rate	Annual Benefits	Annual Costs	B.C.R.	Net Benefits
3-1/4	772,000	250,000	3.09	522,000
7-5/8	720,000	469,000	1.46	251,000

EVALUATION AND TRADEOFF ANALYSIS

This plan provides the least amount of harbor protection; however, it protects a larger amount of shorefront property on the easterly shore, including the U.S. Coast Guard pier. The mathematical model indicates that this plan has the best flushing patterns.

COST APPORTIONMENT

The cost apportionment is based on the ratio of general and local benefits to the overall benefits and is as follows:

	3-1/4%	7-5/8%
Federal (General)		
Corps of Engineers 65%/66%	$3,790,150	$3,848,460
U.S. Coast Guard	6,500	6,500
Total Federal	$3,796,650	$3,854,960
Non-Federal (Local)		
Cash Contribution 35%/34%	$2,040,850	$1,982,540
Total Non-Federal	$2,040,850	$1,982,540

PUBLIC VIEWS

Views of Federal Agencies. The U.S. Fish & Wildlife Service recommends that the 5.0 acres of quahaugs be transplanted away from under the proposed breakwater, prior to construction. The U.S. Coast Guard requested a minimum of a 300-foot width between the pier and breakwater, but the 400-foot width provides better flushing. The National Marine Fisheries Service recommended that current studies be made.

Views of Non-Federal Agencies and Others. The Rhode Island Department of Environmental Management favors Plan B over the other breakwater plans. Bristol officials and others at the public meeting favor Plan B.

PLAN C

PLAN DESCRIPTION

This plan is a double breakwater system. It combines Plan B with a 700-foot breakwater extending from the west shore. The two-breakwater configuration would be a combined total of 2,400 feet.

IMPACT ASSESSMENT

Breakwater Impacts. The alignment would protect both shores as well as the Bristol Yacht Club, Bristol Marine and the Coast Guard pier. About 6 acres of bottom shellfish habitat would be destroyed. This plan allows a higher concentration of water mass to remain in the upper harbor and indicates less flushing than the other two plans.

Navigation Impacts. A slightly off-center 1,000-foot opening would remain for navigation use, allowing for currents. This plan would protect 150 acres of waterway and 1,050 moorings.

Economic Impacts. The estimated final cost of Plan C is $7,911,000. The complete analysis of costs and benefits is shown in Appendix F. A summary of the analysis is as follows:

PLAN - C

Rate	Annual Benefits	Annual Costs	B.C.R.	Net Benefits
3-1/4%	$1,004,000	$341,000	2.94	$663,000
7-5/8%	$854,000	$638,000	1.34	$216,000

EVALUATION AND TRADEOFF ANALYSIS

This plan protects the largest amount of waterway and shoreline; however, it has the worst flushing patterns and would probably be detrimental to the biota and water quality.

COST APPORTIONMENT

The cost apportionment is based on the ratio of general and local benefits to the overall benefits and is as follows:

	3 1/4%	7 5/8%
Federal (General)		
Corps of Engineers 62%/64%	$4,904,820	$5,063,040
U.S. Coast Guard	9,500	9,500
Total Federal	$4,914,320	$5,072,540
Non-Federal (Local)		
Cash Contribution 38%/36%	$3,006,180	$2,847,960
Total Non-Federal	$3,006,180	$2,847,960

PUBLIC VIEWS

Views of Federal Interests. The U.S. Fish and Wildlife Service recommended the transplanting of about 6 acres of quahaugs from under the breakwaters, prior to construction. The National Marine Fisheries Service recommended that current studies be made.

Views of Non-Federal Interests and Others. The Rhode Island Department of Environmental Management favors a single breakwater, as do town officials and others.

COMPARISON OF DETAILED PLANS

In general, the three rock breakwater plans at the head of the harbor are similar, in that they each protect the harbor and shoreline from storm waves originating in Narragansett Bay and provide the opportunities for environmental quality enhancement, navigational improvements and economic development.

In essence the breakwaters vary in location, alignment and degree of protection provided. In comparing the detailed plans, a trade-off must be made between maximization of protection of the recreational and potential commercial fleets and the risk of reducing natural flushing action of the harbor. The degree to which each alternative protects the boats in the harbor and the shoreline and the impacts on pollution and flushing are what differentiate the alternatives.

Plans A and B have a minimal impact on the tidal currents and tide levels and Plan C has the greatest impact. The absolute significance of any increase in tidal currents caused by any breakwater depends on the resultant degree of pollution and flushing action in the harbor. Mathematical analysis indicates that Plan B would be the least detrimental to the flushing action of Bristol Harbor.

Although Plans A and C protect more waterway in the harbor than Plan B, the difference between A and B is small and Plan C costs more than Plan B.

The degree of protection afforded the shoreline is greatest with Plan C, and the least with Plan A. Plan B appears to be a reasonable trade-off among the alternatives considered.

During severe winters ice forms in the upper harbor, however, the breakwaters will not significantly affect the ice problem because of the length and shape of the natural harbor. Plan B, with the largest overall openings, will have the least impact when the ice begins to break up and move out.

COST COMPARISON

All three breakwater plans require similar methods of construction, but vary in magnitude. Plan A would be 1,600 feet long; Plan B, 1,700 feet long; and Plan C, 2,400 feet long. Construction could be carried out from temporary land approaches or from crane-mounted barges. Costs are estimated for barge-mounted cranes and deposition of dredged materials at the Brenton Reef Ocean Dump Site in Rhode Island Sound, just off Newport, Rhode Island. Comparisons of first and annual costs are shown in Tables 3 and 4.

TABLE 3
COMPARISON OF FIRST COSTS

	PLAN A	PLAN B	PLAN C
Construction Costs	$4,385,000	$4,527,000	$6,141,300
Contingencies	657,000	679,000	921,200
Total Construction Costs	$5,043,000	$5,206,000	$7,063,000
Engineering & Design	252,000	260,000	353,000
Supervision & Administration	353,000	365,000	495,000
Total First Costs	$5,648,000	$5,831,000	$7,911,000

TABLE 4
COMPARISON OF ANNUAL COSTS

	3 1/4%	7 5/8%
PLAN A		
Interest & Amortization	$245,300	$442,300
Annual Maintenance	$ 12,700	$ 12,700
Total Annual Costs	$258,000	$455,000
PLAN B		
Interest & Administration	$237,850	$456,850
Annual Maintenance	$ 13,150	$ 13,150
Total Annual Costs	$251,000	$470,000
PLAN C		
Interest & Amortization	$322,500	$619,500
Annual Maintenance	$ 18,500	$ 18,500
Total Annual Costs	$341,000	$638,000

BENEFIT COMPARISON

Each of the detailed breakwater plans would provide sufficient protection to the harbor to prevent damages to the existing boating fleets and the shoreline. In addition, they would encourage new boats to moor in the harbor and provide the opportunity for economic development within the harbor area. A detailed discussion of the anticipated benefits is shown in Appendix F. A summary of the annual benefits of all three detailed breakwater plans is shown in Table 5. Net benefits are shown in Table 6.

TABLE 5
ANNUAL BENEFITS

	3 1/4%	7 5/8%
PLAN A		
Recreational	$572,000	$509,000
Commercial	102,000	102,000
Damages Prevented	55,000	55,000
Total Annual Benefits	$729,000	$666,000
PLAN B		
Recreational	$541,000	$489,000
Commercial	153,000	153,000
Damages Prevented	78,000	78,000
Total Annual Benefits	$772,000	$720,000
PLAN C		
Recreational	$765,000	$615,000
Commercial	153,000	153,000
Damages Prevented	$ 86,000	$ 86,000
Total Annual Benefits	$1,004,000	$854,000

TABLE 6
NET BENEFITS

	3 1/4%	7 5/8%
PLAN A		
Annual Benefits	$729,000	$666,000
Annual Costs	$258,000	$455,000
Net Benefits	$471,000	$211,000
B/C Ratio	2.82	1.46
PLAN B		
Annual Benefits	$772,000	$720,000
Annual Costs	$251,000	$470,000
Net Benefits	$522,000	$251,000
B/C Ratio	3.08	1.53
PLAN C		
Annual Benefits	$1,004,000	$854,000
Annual Costs	$ 341,000	$638,000
Net Benefits	$633,000	$216,000
B/C Ratio	2.94	1.34

Plan C has the largest net benefits for 3-1/4% and Plan B has the largest net benefits for 7-5/8%.

The primary environmental concerns associated with the alternative breakwater plans are the disposal options. The State of Rhode Island does not have an authorized ocean disposal site at this time and one may not be available at the time of construction. Other potential sites within Narragansett Bay are at the Prudence Island Historic Dump Site in the East Passage, the Conimi "Cut Point" in-channel" site, Spar Island, Common Fence Point, and Spectacle Cove in Portsmouth. However, use of these sites is still prohibited.

The town of Bristol has authorized the disposal of approximately 40,000 cubic yards of dredged material in their sanitary landfill area. However, the site would be the least environmentally acceptable site at this time due to the need to transport the dredged material by trucks through the city streets.

Other concerns are changes in the tidal prism water quality and adequate harbor flushing of existing pollutants.

ENVIRONMENTAL COMPARISON

The same types of environmental impacts would result from all three breakwater plans, but the least environmental impact would result from Plan B. A detailed comparison is shown in the Environmental Assesments starting on page 35.

COMPARISON SUMMARY

A comparison of the three detailed plans is shown in the Summary of System of Accounts in Table 7. By displaying the significant beneficial and adverse impacts, the system is intended to assist tradeoff analysis and final decisionmaking. The complete System of Accounts is shown in Appendix B.

TABLE 7
SUMMARY OF SYSTEM OF ACCOUNTS - 3-1/4%

ACCOUNT	PLAN A	PLAN B	PLAN C
A. Plan Description	1600-Foot Rock Breakwaters	1700-Foot Rock Breakwaters	2400-Foot Rock Breakwaters
B. Impact Assessment			
1. National Economic Development			
a. Project Cost	$5,654,000	$5,837,500	$7,920,500
b. Annual Benefits	$729,000	$772,000	$1,040,000
c. Annual Costs	$258,000	$251,000	$ 341,000
d. B/C Ratio	2.83	3.08	2.94
e. Net Benefits	$471,000	$522,000	$663,000
2. Environmental Quality			
a. Tidal Currents	Minimal	Minimal	Slight Increase
b. Dredging Impacts on Water Quality	Temporary	Temporary	Temporary
c. Flushing Patterns	Adequate	Best	Worse
d. Shoreline Protection	Least	Better	Best
e. Aesthetics	Favorable	Favorable	Favorable
C. Plan Evaluation			
1. Achieves Planning Objectives			
a. Protects Boats and Shoreline	Yes	Yes	Yes
b. Provides Opportunity for Expansion	Yes	Yes	Yes
c. Improves Navigation	Yes	Yes	Yes
D. Public Response			
1. General Acceptance	Yes	Yes	Yes
E. Implementation Responsibility			
1. Federal	$3,451,280 (61%)	$3,796,500 (65%)	$4,914,320 (62%)
2. Non-Federal	$2,202,720 (39%)	$2,040,850 (35%)	$3,006,180 (38%)
Project Costs	$5,654,000	$5,837,500	$7,920,500

RATIONALE FOR DESIGNATION OF NED PLAN

An NED (National Economic Development) plan addresses the planning objectives in such a way as to maximize net economic benefits. Net economic benefits are maximized when plan scale is optimized and the plan is efficient. Scale is optimized when benefits of each increment of the plan at least equal economic cost, and a plan is efficient when the outputs of the plan are achieved in a least cost manner.

All three detailed plans yield economic benefits and satisfy the Principles and Standards requirements for a NED plan. However, using the mandated interest rate of 3 1/4 percent, Plan C has the largest net benefits and it is designated as the NED plan.

RATIONALE FOR DESIGNATION OF EQ PLAN

An EQ (Environmental Quality) plan is the alternative which addresses the planning objectives in such a way as to make the most significant contribution to the management, conservation, preservation, creation, restoration or improvement of the quality of natural and cultural resources and ecological systems.

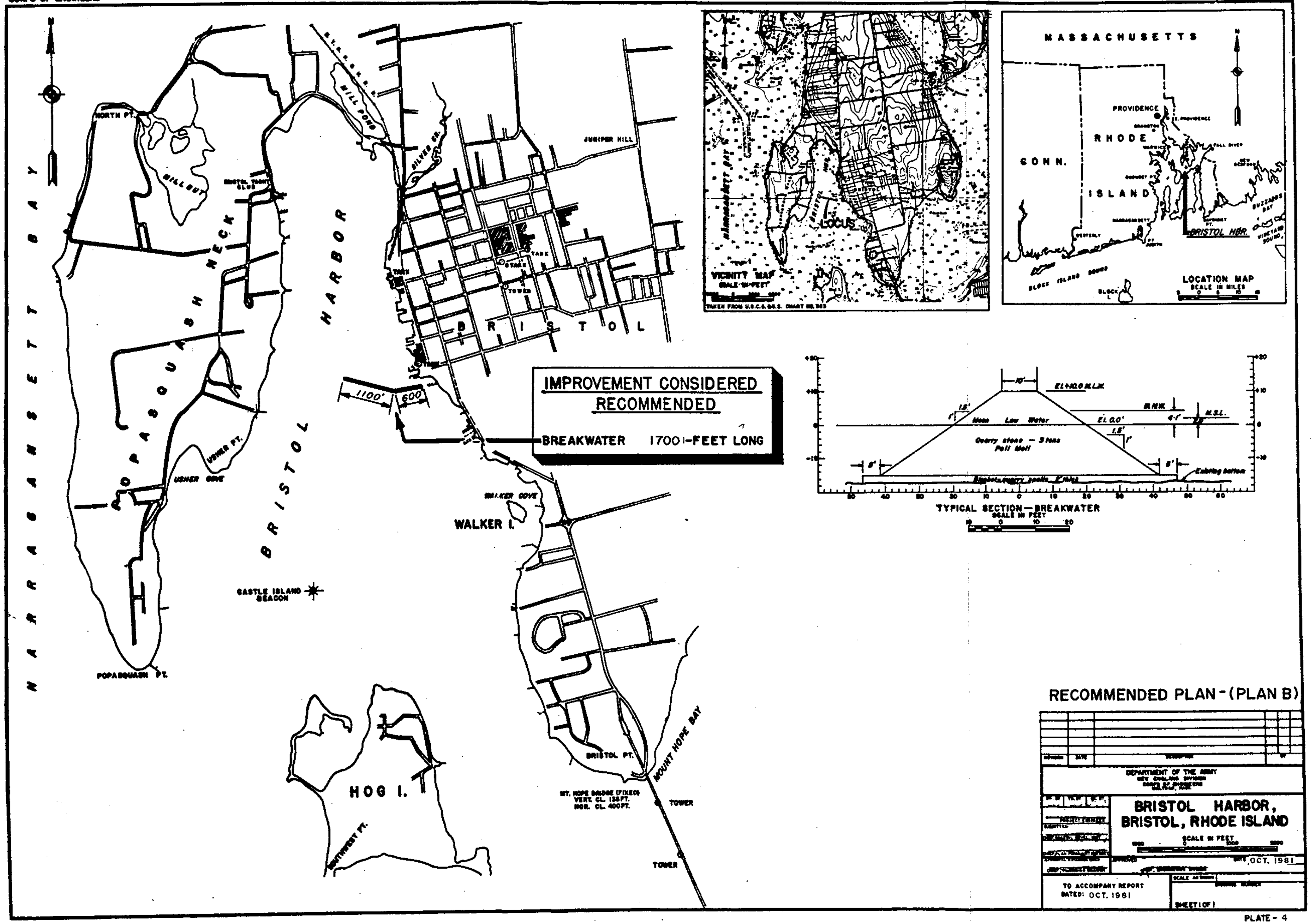
All three considered detailed plans have positive effects on the environment as well as enhancement of commercial and recreational boating and navigational safety.

Mathematical modeling indicated that Plan B was the least detrimental to the natural flushing of the harbor. Plan B also makes the best contributions to the overall environmental objectives and is therefore designated as the EQ Plan.

RECOMMENDED PLAN

The recommended alternative is Plan B. It would provide a 1,700 linear-foot offshore rock breakwater just south of the Coast Guard pier, and a 1600-foot wide access for navigation on the westerly side of the harbor. It would protect the existing and future recreational and commercial fleets, the Coast Guard pier and the commercial/industrial area along the east shoreline, as well as enhance future development of the harbor. Plan B is shown on Plate 4.

The estimated cost of construction for Plan B is $5,831,000. Annual benefits resulting from the plan of improvement would be $772,000 and the annual charges would be $251,000, yielding a favorable benefit cost ratio of 3.08 to 1.0.



IMPROVEMENT CONSIDERED
RECOMMENDED
BREAKWATER 1700±-FEET LONG
1100'
600
NARRAGANSETT BAY
POPASQUASH NECK
BRISTOL HARBOR
BRISTOL
NORTH PT.
MILL GUT
MILL POND
SILVER CR.
JUNIPER HILL
USHER PT.
USHER COVE
WALKER COVE
WALKER I.
CASTLE ISLAND BEACON
POPASQUASH PT.
HOG I.
SOUTHWEST PT.
BRISTOL PT.
MOUNT HOPE BAY
MT. HOPE BRIDGE (FIXED) VERT. CL. 135 FT. HOR. CL. 400 FT.
TOWER
TOWER
VICINITY MAP
LOCUS
MASSACHUSETTS
CONN.
RHODE ISLAND
PROVIDENCE
BRISTOL HBR.
BLOCK ISLAND SOUND
LOCATION MAP
SCALE IN MILES
Mean Low Water
Quarry stone — 3 tons
EL.+10.0 M.L.W.
M.H.W.
M.S.L.
EL.0.0'
Existing bottom
TYPICAL SECTION—BREAKWATER
SCALE IN FEET
RECOMMENDED PLAN - (PLAN B)
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
BRISTOL HARBOR,
BRISTOL, RHODE ISLAND
SCALE IN FEET
OCT. 1981
TO ACCOMPANY REPORT
DATED: OCT. 1981
SHEET 1 OF 1

ENVIRONMENTAL ASSESSMENT
BRISTOL HARBOR, RHODE ISLAND
Proposed Breakwater Construction

INTRODUCTION AND PROJECT HISTORY

In keeping with the National Environmental Policy Act of 1970, the New England Division Army Corps of Engineers has examined environmental values as part of the planning and development of the proposed action plan. Background environmental information was compiled for purposes of this report through interviews with various State and local interest groups and a search of published literature. A reconnaissance shellfish survey, completed by the Corps and R.I. State Marine Fisheries Division, assessed local quahog population densities. A math hydrographic predictive model was run to evaluate effects of the proposed construction on water quality and circulation. This report provides a preliminary assessment of environmental impacts and alternatives considered and contains other applicable data to the Section 404 Evaluation requirements.

The Bristol Harbor, Rhode Island navigation improvement project was authorized on 13 August 1968 by Section 101 of the 1968 River and Harbor Act (Public Law 90-483). Funds to initiate the Phase I, GDM Study were received in October 1978. The authorized project information is contained in H.D. 174/90/1st and no EIS was required for the project at that time.

PURPOSE AND NEED FOR ACTION

There is no Federal, State, or local navigation project in Bristol Harbor. The harbor is exposed to southerly quadrant waves from Narragansett Bay which has limited the potential growth of the harbor for commercial and recreational purposes.

Increased demands for protected recreational boating anchorages, marinas, launching areas, as well as protection for unloading small commercial shellfish boats and shoreline docks and facilities, have been expressed by local officials and waterway users.

Protection of Bristol Harbor from storm and wave action originating from the south to southwest directions would benefit the existing and prospective fleets of commercial and recreational craft as well as waterfront structures. Tangible benefits from such improvements would accrue through increased use of the existing fleet based in the harbor, the addition of new boats to the local fleet, and reduction of damage to vessels and shore facilities.

Increased use of the harbor would be a primary benefit accruing from the breakwater protection. The boating season in this area extends from 1 May through 30 September or 150 days. Wind records of speed, direction and duration show that during the above boating season the winds are predominantly from the southerly quadrant. It is estimated that winds of all speeds from the south are generated about 50 percent of the time and that winds in excess of 8 miles per hour occur 40 percent of the time, in excess of 12 miles per hour 25 percent of the time, and winds in excess of 16 miles per hour occur 10 percent of the time.

The exposure of Bristol Harbor to the south reduces the use of the recreational and commerical fleet in the harbor. The difficulties and unpleasant conditions experienced by recreational craft in the harbor under present degrees of exposure discourage full potential use of the present fleet, partly because of difficulty in mooring and unmooring during periods of moderate to somewhat stronger winds, or in going to and from shore in small craft from the anchored boats. The accumulated effect of these various detractions from use of the fleet is estimated to result in a present use of Bristol Harbor that ranging from 75 percent of the ideal benefit for the smaller craft to 90 percent of ideal for the larger boats. The composition of the existing recreational fleet and the estimated annual benefits to the existing fleet from a protected harbor are shown in Appendix F.

PROPOSED PLAN OF ACTION

The selected plan of improvement, Plan B, consists of:

- Provision for a 1700-foot breakwater detached from the eastern shore

Plan B is recommended on the basis of good flushing and adequate protection from wind waves generated along a southwest fetch. The trade-off for increased protection (larger breakwater) is restricted flushing, which may have an effect on the marine biota and water quality. The length of this dog-leg structure depends on how much protection should be afforded to the industrial area around the town pier. If the need for protection is limited to the area between the town pier and the U.S. Coast Guard Station, then the breakwater could probably be shortened to 1200-1400 feet. The dog-leg configuration would provide better protection than an equivalent straight breakwater for this area. An opening of approximately 400 feet would be left between the breakwater and the eastern shore. This opening would facilitate flushing and circulation.

The exact method of construction of the breakwater is not yet known but may involve one or a combination of the following foundation options:

Option 1 - Displacement/penetration type of construction. This method is particularly feasible for the inner 600 feet of the breakwater where sediment probes indicate the average depth of soft foundation material to be two feet. By displacement it is meant that the rock for the breakwater upon dumping in place would force the soft materials downward and laterally until bottom resistence is met. No dredging would be involved with this method along this portion of the breakwater. Displacement and penetration of the bottom materials along the outer 1100 feet of the breakwater is also possible as the soft material is only about 8 feet deep. A mud wave would be developed on both sides and at the end of this breakwater. Dredging and disposal of the organic mud would be required.

Option 2 - Displacement and penetration of the inner 600 feet of bottom materials and excavation and replacement of soft overlying bottom materials along the outer 1100 feet of breakwater.

Option 3 - Displacement and penetration of the inner 600 feet of bottom materials and placement of a 6-foot thick dumped sand blanket on the existing bottom (no dredging), followed six months later by construction.

Depending on the ultimate breakwater design selected, from 25,000 cubic yards to 42,000 cubic yards of bottom sediments may require excavation. Disposal of the material is currently being coordinated with town officals and the Rhode Island Coastal Resources Management Council. The Bristol Town Council has voted to approve of disposing the dredged materials in the town landfill (see letters, 8, 11, & 17 June in Appendix C.) The Coastal Resources Management Council has informed the New England Division by letter of 15 June that efforts are underway to prepare a special area plan for the Brenton Reef dredged material disposal site. This site is envisioned as the State's future open water regional disposal area.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Possible navigation improvements in Bristol Harbor were investigated based on the evaluation of problems and needs identified by local interests. In considering the protection needs of the existing commercial recreational fleet at Bristol Harbor and maintenance of water quality, three alternative plans of improvement were established.

In order to understand the present conditions existing in Bristol Harbor with respect to tidal circulation, a two-dimensional numerical, hydrodynamic model was applied to the study area for mean and spring tidal ranges. These circulation results are subsequently used as input for a two-dimensional numerical dispersion model for the purpose of simulating pollutant dispersion and flushing. Once the existing conditions of flow and transport are known, the effects of each breakwater plan on circulation and dispersion can be measured by comparison. The primary concern of this modeling effort focuses on the prediction of the impact each breakwater will have on harbor flushing and related water quality.

From the results of these numerical models two other topics can be addressed using analytical procedures. The first analysis concerns the effects of wind stress on the predicted tidal circulation and flushing in Bristol Harbor with and without breakwaters. The second analysis concerns the effect of installing a 6-foot by 6-foot culvert within the 700-foot western breakwater of Plan C. From the previous numerical and subsequent analytical results, recommendations are made for the various breakwater configurations.

<u>Plan A</u> - the Congressionally authorized offshore breakwater 1600 feet in length. The location of this structure would allow for an 1100 foot passage on the western side and a 400 foot passage to the east.

<u>Plan B</u> - would provide for a 1700 foot breakwater detached from the eastern shore.

<u>Plan C</u> - would provide for Plan B and an additional 700 foot structure extending from the west shore.

These different breakwater configurations would cause the upper harbor's circulation pattern to change radically compared to natural conditions without a structure(s) in place. Current speeds, predictably, would tend to increase in the regions around the breakwater. Additionally, the breakwaters would also create eddies or localized areas of turbulence.

Each breakwater would have the same general effect on upper harbor circulation although the current speeds and the number of eddies vary. Maximum eddy velocities occur about an hour before and after slack water. During slack water the eddies remain organized but currents decrease in speed somewhat. During the mid-ebb and mid-flood the eddies become disorganized and have minimum current speeds. The eddy rotation directions reverse as they reorganize after the midpoint is passed.

Breakwater A, which would provide the widest openings into the upper harbor, would have peak currents in each passage of only about 11 cm/sec. Breakwater B with its constricted east passage could develop peak speeds in both passages of about 11 to 13 cm/sec. Breakwater C, which would restrict flow into the inner harbor, would cause speeds in the eastern passage of 11 to 13 cm sec, but in the western passage between the two breakwaters, themselves would peak at 20 to 25 cm/sec.

<u>Plan D - Hurricane Barrier</u>

A hurricane barrier at the head of Bristol Harbor was investigated as a result of inquiries from local officials, as to the feasibility of constructing such a structure to protect the entire recreational and commercial fleets and shoreline within the harbor from storm induced waves and periodic hurricane damage to the commercial and industrial area along the easterly shore.

The hurricane barrier would involve construction of a rock structure similar to the above breakwaters. It would extend from shore to shore, a distance of about 4,400 feet, with a top elevation of 22 feet above mean low water and sides slopes of 1.5 to 1.0. The hurricane barrier would have a 100-foot gated opening for normal navigation purposes and would be closed during hurricanes. Sluice gates on either side of the navigation opening would reduce tidal currents during normal periods. An earth dike would be required at Mill Gut to prevent "back-door" flooding across the neck at the west side of the harbor.

Plan E - Floating Breakwaters

A concrete floating breakwater was examined as a possible alternative to a permanent rock breakwater for Bristol Harbor. A breakwater of this sort could could consist of floating concrete blocks filled with styrofoam. Each block is approxmately 15 feet long by 5 feet deep by 3 feet wide. These blocks, connected with bolts and rods into a lattice type configuration, are assembled into 60-foot modules. The whole structure is then anchored with heavy chains and 25 ton anchors on each side. A floating breakwater of this sort would be used to protect the whole harbor or just specific areas. Maintenance costs of this type of structure are very high, and its replacement would be required every 10 years. Another limitation is that a floating breakwater will only dissipate waves of 2-3 feet, while the design wave of 4 feet was determined for Bristol Harbor. The cost for floating breakwaters would be solely the responsibility of local interests.

Environmentally a floating breakwater, i.e., tire or cement, would cause considerably less disturbance and alteration to the bottom habitat and could eliminate the need for dredging which is an inherent problem for disposal of dredged materials. The floating blocks as well as the anchor weight and cables would provide surfaces for the survival and growth of epibenthic fouling organisms, i.e., barncles hydriod mussels, ectoprocts, algae. This type of growth, however, while acceptable and even beneficial on the permanent rock breakwater, would serve to increase maintenance frequency and costs of the floating structures. The growth of these plant and animal communities would also influence the buoyancy which would greatly reduce the structure's capacity to disrupt wave energy.

Nonstructural & Management Operations

a. Flood Insurance.

In addition to the construction of a breakwater structure, nonstructural alternatives were considered as possible solution to local interest needs and concerns.

The National Flood Insurance Program is a nonstructural measure established in 1968, and serves a dual purpose. First, it provides people whose homes or businesses presently are located in flood prone areas with subsidized insurance coverage. Second, it requires that communities wishing to participate in the program manage their flood plains in ways (i.e. zoning) that eliminate or reduce future flood damage. Given that Bristol is in the National Flood Insurance Program, any new construction would be subject to criteria designed to minimize the flood hazard.

The Federal Emergency Management Agency has recently announced that the National Flood Insurance Program will be revising its reports to include wave height rather than just the stillwater (tidal) elevations of a 100-year storms (CZ '80 conference, John Macy, Dir. FEMA).

Through local initiative, combined with use of the flood insurance program of the constructive total loss concept, development patterns can be shifted away from high-risk areas. If, after a disaster, local authority move to prevent rebuilding and dedicate an area to nonhazardous use, the flood insurance program will pay the limit of its policy to the property owner.

Another policy involves deletion of insurance rates for structures in high-hazard coastal areas; such rates are set only after individual inspection of the sites.

Environmentally, this alternative would prevent the local impacts to the water quality and ecology of the harbor.

Other nonstructural harbor management measures considered included strengthening of moorings and mooring lines, and removal of boats from water or evacuation of boats to a safe harbor. These measures would help reduce damages to the boats, but would have no effect on the rough seas and winds and would not enhance the commercial or recreational potential of the harbor.

Shoreline management methods considered included reinforcement or removal of existing docks by private interests. This action would reduce damages that might normally be incurred, but would not guarantee protection against more severe future storms that may enter the harbor. There would be no Corps of Engineers participation in these alternatives, and the costs would be the responsibility of local interests.

Breakwater Foundation Options

Three alternate foundation options were considered for the Phase I General Design Memorandum (GDM). Sediment probes indicate the average depth of soft overlying layer to be 2 to 8 feet and the displacement, removal, or blanket type of construction is feasible. The displacement method is the simple placement of stone and rock material which when dumped penetrates through the soft muds to a point of refusal with lateral displacement of the finer sediments resulting. The removal method will include dredging of soft materials and replacement with sandfill.

Blanket construction consists of placement of a 6-foot thick dumped sandfill material on the existing bottom, followed six months later by construction of the remainder of the breakwater. This alternative is dependent on the shear strength of the bottom muds and would require further sampling and testing during Phase 2 of the study if this alternative is to be seriously considered.

Approximately 24,000 to 42,000 cubic yards of bottom material will have to be dredged and disposed of (depending on the ultimate dimensions of the bottom width of the breakwater, either 120 feet or 170 feet). The alternative of laying down a sand blanket will serve to consolidate the soft foundation muds and provide a firmer surface area on which to support the breakwater. It is anticipated that the sand blanket option would also eliminate the need for dredging and its inherent disposal problems. However, either dredging or laying a sand blanket would remove or smother benthic biological communities. Approximately 6.6 acres of subtidal habitat would be altered. This does not mean however that the impacts are entirely negative. In fact the riprap or dumped rock surfaces are as biologically desirable as mud bottom or may be even more so since they provide more habitat for epifaunal invertebrate species. The proliferation of attached organisms and algae and the grazers (i.e. fish, crabs, lobsters, starfish) which they attach is expected to offset the reduction in shellfish bottom and infaunal populations.

Disposal Options

Each of the possible disposal options would have some environmental impact, whether in the ocean, on land, in diked disposal areas near the waterfront or marsh creation. It is difficult to compare impacts under widely varying conditions against each other. The major concerns are potential for impacts on identified commercial marine resources and potential for addition to general low-level deterioration of the overall ocean resources. At present, there is no State approved open-water disposal site in Rhode Island waters. Discussions of disposal alternatives and identification of potential disposal sites in Mount Hope and Narragansett Bays are given in Seavey and Pratt (1979) and the Draft Environmental Impact Statement for the Fall River Harbor Improvement Dredging Project (Feb. 1976).

Ocean Disposal

a. Brenton Reef - Newport Historic Dump Grounds - The advantage of this site is its previous history of use and the fact that there is more scientific information regarding this site than any other in the area. However, there is the concomitant disadvantage of historic opposition by commercial fishing interests and conservation groups to dumping at this site. The site is located approximately 20-22 nautical miles from Bristol Harbor. Travel time, therefore, and related costs would be significant. The results of the bulk chemical analysis of the bottom sediments to be dredged indicate that the material is acceptable for disposal in the ocean.

environment. The Rhode Island Coastal Resources Management Council has recently informed the Corps that it is "preparing a special area plan for the Brenton Reef disposal site and it is being viewed as the State's open water disposal ground." Through the Marine Protection Research and Sanctuaries Act, Public Law 92-532, the U.S. Environmental Protection Agency is designated regulatory authority for ocean disposal of all substances. However, the Corps of Engineers has jurisdiction regarding issuance of permits for ocean disposal of dredged material subject to final approval by EPA. The EPA is also empowered to designate the appropriate ocean site for disposal purposes irrespective of the chemical and physical characteristic of the dredged material. The Corps may, however, request that EPA pass judgement on Corps-recommended site(s). Neither agency has recommended utilization of this site in conjunction with the proposed plan.

b. Prudence Island - Prior to 1967, maintenance dredge disposal operations from Mt. Hope Bay and the East Passage were dumped "in-channel" at this site. Water depths range from 76ft. to 110 ft. Sediment grab samples analyzed by U.R.I Scientists in 1978 from the deep hole showed the bottom to be composed of soft silty muds. This sediment type would suggest that the site does possess containment properties and that spoils deposited in the past are being buried by present day sedimentation process. However, no specific studies have been performed which would confirm the site's geophysical characteristics. There is also some commercial trawling activity of a limited extent in the area. The Rhode Island Coastal Resources Management Council views this site as being less preferable than the Brenton Reef disposal site.

c. - Conimicut Point - This is another "in-channel" deep hole or depression area which was utilized for disposal of maintenance dredged material excavated during 1975. U.R.I., under contract to the Corps monitored the dredging and disposal operations (Pratt and Bisagini 1976). They reported turbidity to be minimal around the immediate dredge work area. Dumped suspended sediment was transported with prevailing currents but remained in the channel and below the thermocline. Past disposal in 1978 revealed cohesive silt with shell, pebbles and sand, indicating some erosion of the finer materials had occured. Based on these findings it is concluded that this site is more dispersal than containment in nature and unsuitable as a repository for fine-grained incohesive sediments.

d. Spar Island - Situated off the east side of Bristol Neck near the center of Mount Hope Bay, this islet is located about 5-1/2 nautical miles from the proposed construction site. The town of Bristol Rhode Island states that their claim to this island stems from the 1680 charter under which it was incorporated. This site is advantageous from the point-of-view that it is relatively isloated in the middle of the bay and was previously used and in part constructed from dredged materials. Diking would be required and costs would be significant. However, the site has the potential long-term benefit, if diked, to accept dredged material from various navigation projects within the region, as well as providing useable land once the confinement facility is filled to capacity.

e. Common Fence Point and Almy Point - These two areas near the northern end of the Sakonnet River in the town of Portsmouth were identified by U.R.I. as being capable of accepting more dredged material. Diking would be required, and as with Spar Island, the major ecological impacts would be eliminated or alteration of subtidal bottom habitat.

f. Spectacle Cove - Sand and gravel mining have taken place in the large protected cove indenting the northeastern shore of the town of Portsmouth, resulting in some 80-feet deep holes which can conceivably be filled with dredged materials. Since the site is protected from wave action and currents, marsh establishment or enhancement would be feasible. Environmental effects, with the exception of possible turbidity, would be minimial.

Upland Disposal

The Bristol Town Council has voted to approve of disposing of the dredged materials in the town landfill. This disposal option would be exercised in the event that use of Brenton Reef or an alternative ocean disposal site is not resolved. Several options have been considered using hydraulic or bucket dredging equipment, material rehandling in shallow waters or diked area, and trucking the material two miles through downtown Bristol to the town landfill area. The least expensive system (use of bucket dredge, barge, dragline and trucking) would be less environmentally and economically suitable than ocean disposal.

No Action

If Bristol Harbor is to obtain protection for its navigation-related mooring, anchorage and shoreline facilities, then some form of structure will be required to counteract southerly winds. Accordingly, "the improvement" option is consistent with the new opportunties for growth and economic vitality at Bristol Harbor. It does not conflict with local and State development plans for the harbor.

III. Environmental Consequences
Probable Impacts from the Proposed Breakwater

Water Quality

A quantitative hydrographic model was used to obtain information as to current circulation changes and effects on flushing that could be anticipated with construction of a new breakwater.

The model was refined for the Bristol Harbor area from a vertically averaged model developed by Swanson and Spaulding (1975) for Narranganset Bay. Predicted values were compared to available historical information and tidal currents in the area to validate the predicted flow patterns.

To maintian good water quality, one must maintain an adequate exchange of Bristol Harbor water with East Passage water. The basic operating force in movement of water is currents. There are two types of currents: tidal and wind generated.

The observed current field in Bristol Harbor is determined by the wind and a northward regional flow outside the harbor.

Flushing is important when considering the effect of pollution on benthic organisms in the upper harbor. Plans A and B have dispersion patterns similar to those without a breakwater. Therefore, the impact of either Plan A or B is expected to be minimal with respect to the biota since the flushing is adequate. On the other hand, Plan C appears to allow a higher concentration water mass to remain in the upper harbor during a portion of the tidal cycle. This entrapment indicates a less efficient flushing of the upper harbor, and biota is exposed to a more polluted water mass. On the basis of flushing, either Plan A or B would maintain the present water quality within the upper harbor.

Three sources of pollution have been identified. Dispersion within the harbor has been mapped by simulating the mixing of dye released form the source points. Eighty-three percent of the input is assumed to originate from the Walker Cove outfall from the town's primary sewage treatment plant, sixteen percent form the industrial area adjacent to the town pier and one percent from the Bristol Yacht Club area. Concentrations within the upper harbor without a breakwater are maximum at high-slack and minimum at low-slack water. Dispersion patterns for breakwater Plans A and B most resemble the ambient pattern since those plans are less restrictive with respect to flow. The concentrations mapped for Plan C indicate a tendency for higher concentration buildup during certain tidal phases. This means that the flushing for Plan C is not as efficient as the other two. This buildup may also have adverse effects on the biota, especially shellfish populations and other benthic species.

Plan A was dropped from further consideration as a viable plan due to inadequate protection of the commerical and industrial shoreline from wind waves.

Plan C represents a trade-off of increased harbor protection with reduced flushing, which may have an effect on both biota and water quality. The short, western breakwater proposed as part of this alternative plan could restrict flushing relative to present conditions and provide more protection than may actually be needed.

Plan B appears to best fit the criteria of good flushing and adequate protection. Findings support this configuration as first choice for construction.

In the context of this study area, there does not appear to be any particular orientation of the breakwaters which would enhance flushing. However, both Plans B and C should be detached from shore to eliminate entrapment of debris, reduce channel velocities and maintain tidal circulation.

Wave -- Breakwater Interaction

The most visable effects of wind blowing over water is the generation of wind waves.

The wind waves of interest in coastal areas are called shallow-water or short waves. Characteristically, they have a depth-to-wave length ratio (d/L) of less than one-half. Shallow water waves, exhibit three important properties: reflection, diffraction and refraction (Bascom, 1964). In reflection, a portion of the wave energy is redirected in the interaction with a solid barrier. In diffraction, wave energy dissipates into the geometric shadow of the wave train as it passes a solid barrier. In refraction, bottom friction and depth changes cause the wave direction to change with a roughly perpendicular orientation on the bottom contours. As the waves enter shallower water, the waves velocity decreases, the wave length shortens and the wave steepness increases. Finally at a depth equal to about 1.3 times the wave length, the wave becomes too steep to remain stable and breaks.

Maximum fetch for Bristol Harbor appears to be about 3 nautical miles (5.6 km) from the southwest.

Standard procedures to determine water wave properties have been established by the U.S. Army Coastal Engineering Research Center (1973). Comparing Plan A to the diffraction diagrams indicates that town pier would not be adequately protected from waves coming along the axis of maximum fetch. However, the dog-leg breakwater of Plan B would ensure wave-height reduction in the town pier area of over 80%. No significant interaction of diffraction waves would take place between the two breakwaters of Plan C. Each breakwater design would result in significant reflection of waves away from the harbor, with no problem of waves being reflected into the harbor. Using the rule of thumb that wave directions become orthogonal to the bottom contours. It appears that waves entering the harbor along the axis of maximum fetch may be directed through the eastern pass around Breakwater A into the town pier region. The dog-leg breakwater of Plan B would effectively stop those waves.

Erosion

The shoreline of the harbor is generally rocky, consisting of large areas of ledge outcrop. Because there is little movement of littoral materials, it is considered that the construction of a breakwater would have negligible effect on the configuration of the adjacent shoreline.

Effects on Currents and Circulation

The application of the model to Bristol Harbor as it presently exists (i.e., no breakwater) shows a very simple two-dimensinal circulation pattern. During the ebb, currents flow counterclockwise around Hog Island in the lower harbor and seaward (south) in the upper harbor. On the flood, these currents reverse. The breakwaters each have the same general effect on upper harbor circulation while not affecting currents in the lower harbor. Eddies are formed north and south of each breakwater, their maximum speeds occur an hour before and after slack water with a relative minimum during slack water. During mid-ebb and mid-flood these eddies disorganized but shortly afterwards they reorganize in the reverse direction. Tidal heights are not signficantly altered by the breakwater construction with an overall range differnce of several centimeters.

Without any breakwater, analyses indicate that the upper harbor tends to be dominated by wind-driven circulation rather than tidal circulation. Northwest winds which predominate in winter increase flushing. Southwest winds characteristic of summer retard flushing, but, as they are generally weak, they are not a serious navigation problem. The restrictive nature of a breakwater causes increased current speeds within and around the upper harbor. Although upper harbor circulation with the breakwaters would still be influenced by wind efects, the increased current speeds would help to insure harbor flushing.

Wind waves are expected to be fetch-limited and substantial generation is expected only from a southwest wind. The dog-leg breakwater of Plan B seems adequate to protect the town pier area from the waves generated along the area of maximum fetch, whereas the single, straight breakwater of Plan A appears inadeqate. Winds from other directions do not have as large a fetch, and wave production should be significantly reduced. In this respect, unless there is a major problem with wave damage from south winds at the Bristol Yacht Club, the short western breakwater of Plan C is not necessary.

Dredging and Disposal Effects

Sediment Analysis

Direct effects on the physical, chemical, and biological environment, resulting from dredging activity and breakwater construction, depends on the type of dredging method utilized, the quality of the sediments, and the magnitude of the impacts proportioned to the quantity of dredging. In order to determine the suitablity of the material to be dredged for fill or open water disposal, bulk chemical and elutriate tests have been completed. The results of these tests are given in Tables 1 and 2.

The NED Army Corps obtained three (3) sediment surface grab samples in 1980 along the proposed breakwater alignment. The sediments were visually classified as dark gray sandy silty clay with a hydrogen sulfide odor. The percent fine material characterizing these sediments was 84% and 90% for the two westernmost located stations and decreased to 51% at the station sampled nearest shore. These data agree with the probings made to assist the structural and design evaluation. The carbon content of the bottom sediments exhibit a linear increase east to west with decreasing sediment size. The total carbon concentration of 6.77% is extremely high and may be a limiting factor in the development of diverse benthic communities in this area and is probably due to the organic loading from local sewage and industrial effluent discharge. No abnormally high concentrations of heavy metal, hydrocarbons or organics are seen in comparison with other Rhode Island harbors of similar size located within the bay. It is felt that further chemical testing of the sediments is not warranted, and the material is suitable for open water disposal.

A pertinent legislative document is the Fedeal Water Pollution Control Act and its amendments of 1972 (now called Clean Water Act). This legislation is responsible for the Corps 404 program. Dredged material dumped in waters lying within the State's jurisdiction a 3-mile limit of the territorial sea come under 404 regulations. Water lying landward within the "baseline" (defined, as mean low water) of the territoral sea and subject to only 404 would generally apply to such water bodies or bays, estuaries, coves, inlets, etc. Narragansett Bay and these open-water disposal sites considered on pages 49-50 of this assessment, for example, would come under 404 regulations only. For most areas beyond the baseline of the territorial sea (i.e., Brenton Reef and other sites in Rhode Island Sound) out to the 3-mile limit, both 404 (Clean Water Act) and ocean dumping (MPRSA) criteria would apply. MPRSA criteria apply to projects with proposed dumping beyond the baseline. It should be recognized that for 404, the Corps in conjunction with EPA developes criteria, while for ocean disposal the Corps in consultation with EPA developes criteria.

Table 1
Bristol Harbor
Bottom Sediment Test Results

Parameter	GE-1	GE-2	GE-3
	Sample Number		
Vis. Classif.	Dk. Grey Sandy Silty Clay	Sandy Clayey Silt	Fine Sandy Silty Clay
% Fine	51	84	90
% Vol. Solids - EPA	5.72	7.99	11.12
COD	66,300	87,100	175,000
TKN	2,470	4,030	5,130
Oil & Grease	1,000	1,200	1,430
Hg	1.1	1.3	0.3
Pb	51	51	26
Zn	190	154	104
As	13	14	36
Barium	<25	<25	<25
Cd	2	2	1
Cr	64	101	50
Selenium	4.7	5.9	3.2
Ni	19	38	25
Si	133	<100	100
Beryllium	50	<25	25
V	<40	40	40
%Total Carbon	1.82	4.01	6.77
Organo-Chlorine Pesticides (PPS)	<0.05	<0.05	<0.05
DDT (ppb)	-	-	<1
PCB (ppb)	-	-	120
Radioactivity (Mr/Hr)	7	8	7

Biological and Physical Effects of Dredging

The major effect of dredging is the removal of habitat and organisms from the harbor bottom. However, in an effort to mitigate shellfish losses it may be possible to coordinate a State or local quahog transplant operation from the impact area to a shellfish management area prior to construction. Concomitant with this is the spreading of a turbidity plume and the presentation of a large surface area of sediment to the water column. This large surface area allows chemical exchange to take place between the sediment and the water column. Stern and Stickle (1978) point out that turbidity "may reduce photosynthetic activity by interference with light penetration." Laboratory studies on the effects of turbidity indicate that increasing concentrations of suspended sediments produce abnormal development of bivalve eggs and larvae. Adult biavalves seem to cope well with increased turbidity, and adult fish are more sensitive to turbidity than most invertebrates. Stern and Stickle (1978) conclude, however, "The literature indicates that turbidity and suspended soils conditions typically created by most dredging operations are short duration and unlikely to produce severe and irreversible ecological effects."

The primary physical effect of dredging in the harbor will be an increase in suspended solid concentrations due to bucket loss during each movement of the dredging bucket. According to Bohlen (1978), these losses range from 1.5 to 4.0 percent of each bucket load. A hydraulic dredge would produce less turbidity.

Work in the Thames River, Connecticut, has shown that dredge-induced resuspension of sediments is "primarily a near field phenomenon and represents a relativley small scale disturbance of the suspended material field within the estuary" (Bohlen, 1978). Any increase in total suspended sediment concentration will be noticeable over a relatively small area.

The dredging will modify the bottom over an area whose dimensions and location vary with the alternatives discussed. Plan C and the alternative of a hurricane barrier would impact the largest bottom area.

Disposal Effects

Immediate effects of dredged material disposal in the marine environment are two fold. Both are short term effects. The first is the effect of the exposure of sediment surface to the water column while the sediment drops though the water column and the second is the smothering of the existing bottom community.

Immediately following a disposal operation, dissolved oxygen and pH levels are expected to be depressed within the turbidity plume itself. Also, within the plume, the concentration of suspended solids, volatile solids, and organic carbon are expected to increase as a direct result of sediment disposal.

The benthos beneath the disposal point are smothered by the rapid influx of new material. The results of the smothering are dependent upon the resiliency of the community and the ability of independent organisms to burrow their way to the surface. The addition of sediment of a type different than the existing sediment may result in a permanently altered final community. Rhoads (1978) has indicated that "managed" disposal could enhance the productivity of a disposal site.

IV. Affected Environment

Bristol Harbor is located between Poppasquash and Bristol Necks on the upper protion of Narragansett Bay. This harbor with the surface area of 10.8 square miles (28 km^2) has no appreciable source of fresh water inflow. However, two small bodies of water, Mill Pond and Silver Creek, are located at the northern end of the harbor.

The town of Bristol, located 13 miles (20.9 km) southeast of Providence, dominates the eastern shore of the harbor. This small but growing community had a population density of 1751 per square mile (676/km^2) as of 1970 within an area of 10.2 square miles (26.4 km^2). This community with its rich and colorful history dates back to 1681, and has always had a maritime tradition which included ship-building after the Civil War and recreational boat building after World War II. Like many other coastal New England towns, Bristol's economy changed from an agriculture basis to manufacturing during the course of the Industrial Revolution and remains so today.

The Narragansett Bay area is presently extensively developed and with normal growth over the next 50 years most of the land will be completely utilized for residential, commercial, and industrial purposes. The Bay area has been and is becoming increasingly the most popular area for recreational boating. It is one of the more prolific shellfish producing areas and supports a fishing fleet of substantial size. The popularity of the area is attested by the fact that of the more than 20,000 recreational craft registered in Rhode Island in 1964 nearly all (95%) are located in Narragansett Bay. The growth of recreational boating in the area in the past decade has been of such magnitude that availabiliity of adequate mooring and berthing space has not kept pace with this growth.

Bristol Harbor within the complex of Narragansett Bay is a natural harbor with depths well in excess of those required for the recreational and fishing craft that use Narragansett Bay. It is near in the geographic center of the bay, and the natural protection afforded by the harbor makes it attractive to small craft. Its primary disadvantage, which local interests desire to mitigate, is its exposure to wind and wave action from the southerly quadrants.

Hydrography

The National Ocean Survey (NOS) has produced tables for tidal currents (NOS, 1980a) and tidal heights (1980b) in or near the study area. Currents at the Mount Hope Bridge which connect Bristol Point to Aquidneck Island average 1.1 knots (0.6 m/s) at 47^o true at maximum flood and 1.4 knots (0.7 m/s) at 230^o true at maximum ebb. The minimum before both flood and ebb is zero indicatng the currents here are bi-directional. The range of the mean and spring tides at Bristol Point, where the Mount Hope Bridge connects the Bristol Neck, is 4.0 feet (1.2 m) and 5.0 ft (1.5 m), respectively. At the town of Bristol, the mean and spring tide ranges are 4.1 feet (1.2 m) and 5.1 feet (1.6 m), respectively.

Ecosystem Classification

According to Odem et al's (174) classification of coastal ecological systems Bristol Harbor represents a "neutral embayment" environment (7). A neutral embayment is a partially enclosed coastal area which receives negligible river drainage and is characterized by low turbidity and sedimentation rates, relatively constant salinity and seasonal variation in biota. Circulation patterns in a neutral embayment are primarily controlled by the interaction of the amount of wind stress on the surface waters, tidal changes, temperature structure and configuration of the harbor.

Water Quality & Circulation

The harbor connects with Narragansett Bay by two passages, one on each side of Hog Island. Tides in the Bay as well as the harbor, are dominated by the lunar, semi-diurnal tidal component. The harbor is a small embayment which behaves within the context of the larger, overall behavior of Narragansett Bay.

The town of Bristol generates harbor pollutants from three main sources. About 2.5 million gallons per day (110 liters/second) of treated effluent are discharged into the lower harbor west of Walker Island from the local primary sewage treatment plant. (Construction of secondary treatment facilities is underway.) Manufacturing and docking facilities occupy an 800-yard (732 meter) stretch of shore along the upper harbor and constitute a second source of pollution. Lacking any specific data from this area, the figures are generally considered to be of the order one-tenth that of the sewage treatment effluent. A third source of pollution in the harbor is the Bristol Yacht Club and is estimated to be one-hundredth that of the sewage plant.

Shellfish Resources

Bristol Harbor supports a commercially productive Mercenaria quahog shell fishery (EPA and RI State Shellfish Atlas, 1974). However, a pollution closure line runs directly down the center of the harbor and the actual harvestable sea bottom area is confined to the westward side of the project. Bay scallop beds are also known to exist off Usher point at the extreme end of the harbor.

A reconnaissance quahog survey was conducted 21 March 1979 (Ganz, 1979) of the proposed project site. A series of 5-minutes dredge tows were made at nine locations within the general proposed construction area. Quahog abundance within the breakwater site were insignificant ranging from 6 to 14 in number. Other stations immediatley south and west of the site contained greater abundance of chowder size clams ranging from one to four bushels. These densities were expected as the area is close to harvest due to pollution. These populations, however, provide a valuable seed stock to the upper bay reaches. The construction of the breakwater would eliminate approximately 4-6 acres of bottom shellfish habitat. This impact will be offset by the breakwater structure itself which will provide hard surfaces for the attachment of various epifaunal invertebrates and habitat for fish, lobster as well as mussel production.

Benthic Biology

Samples were taken 5 May 1981 at six stations along the proposed breakwater alginment. A standard (23cm x 23cm) PONAR grab was used for collection. Two replicates were obtained at each station and all samples were processed through a 0.5mm sieve. The number of species were fairly consistent between replicates, but the number of individuals varied between grabs and stations. Species diversity (number of species) ranged from 21 to 42 species and densities ranged from a low of 261 individuals at station 1 to a high of 2305 individuals at stations 5. The large numbers of individuals are thought to be above the normal average of individuals and represent a relatively high number for a northern estuary. The occurence of different populations of benthic organisms is generally related to bottom type. Mud bottoms are dominantly inhabited by organisms that burrow or inhabit various kinds of tubes (infauna). This is true also in Bristol Habor where the clay-silt muds characterizing Station 4 and 5 contained extremely high number of polycaetes Mediomastus ambiseta and Streblospio benedicti and the tube dwelling amphipod Ampelisca abdita. Two small, burrowing bivalve species also dominant at these stations are Mulinia lateralis and Nucula proxima. All of these species are conisdered to be R-type strategist or oppuntunistic species whose life histories are characterized by high reproductive rates and short-life span. These species have also been identified with rapidly colonizing disturbed areas and would be expected to repopulate quickly upon completion of dredging or other construction activities. Stations 1 and 2, closest to the eastern shoreline, are characterized by hard packed sands, gravel, stone and shell. These stations dipslayed a higher species diversity, because of the variety of substrate types but lower number of individuals. These stations were dominated by the polychaetic Polydora ligni, Streblospio benedicti and Mediomastus ambiseta, the mussels Crepidula fornicata, C. plana, Anomia sp. and Telina and the barnacle Balanus venustus. The construction of a breakwater is seen to create an artificial reef type environment favoring the development of a hard surface epifauna community which would replace a segment of the soft-bottom benthic community. The production value of the two community types as food source for various finfish and large crustaceans is thought to be similar. A species inventory list is shown in Table 3.

Historical-Archaelogical Features

The State Historical Preservation Commission (23 June 1980) has reviewed the preliminary alternatives considered by this report and has determined that no impact or effect is expected on archaeological resources. Two National Register districts were identified, and these are the Bristol Waterfront Historic District and the Poppasquash Farms Historic District. The first area will be beneficially affected by the proposed plan in that the design of the breakwater and its location (Plan B) will provide maximum protection to this waterfront and associated marine related businesses.

Endangered Species Impact

There are no rare or endangered species in Bristol Harbor - therefore the proposed breakwater construction will not impact any such species.

Beneficial Impacts

Recreational benefits for improvement of Bristol Harbor have been estimated for the existing fleet of 250 locally based craft ranging from outboards to cruisers and auxiliary sailboats. A protected harbor will result in expansion of the existing fleets. An immediate increase of 40 boats is estimated to occur with an additional gradual growth over the 50-year life of the project. The projected harbor areas were divided into three categories; areas subjected to waves of one foot or less, one foot to 1.5 feet, and 1.5 feet to 2.0 feet under storm conditions. It was considered that 10 boats an acre could moor safely when subjected to waves up to one foot in height, 8 boats an acre could moor safely when subjected to waves between 1 foot and 1.5 feet, and 5 boats an acre could be moored safely when subjected to waves between 2-foot and 3-foot in height.

V. Public and Agency Involvement in the Planning Project

The proposed project plan has been coordinated with the major State and Federal regulatory agencies represented by the U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, National Marine Fisheries Service and Rhode Island Department of Environmental Management and Coastal Zone Resource Council.

These agencies as well as local officials from the town of Bristol were notified of the plan formulation and implementation schedule and plans. A public meeting was held on 21 August 1980. Local interests have provided verbal and written assurances to have the Corps continue with the study.

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ENVIRONMENTAL PROTECTION STATUTES
RELATIONSHIP OF PROPOSED BRISTOL HARBOR, RHODE ISLAND PROJECT
TO ENVIRONMENTAL REQUIREMENTS

Federal Policies	Plan B Breakwater Construction
Archaeological and Historical Preservation Act	Town of Bristol waterfront and harbor on National Register; breakwater design and materials must be compatible with
CZM Act of 1972	Partial Compliance; requirement will be met upon completion of review of EA and finalization of plans
Endangered Species Act of 1973	Partial Compliance; requirement will be met when EA is reviewed.
Estuary Protection Act	"
Clean Water Act	"
Fish and Wildlife Coordination Act	"
Marine Protection, Research and Sanctuary Act	"
NEPA	"
Rivers and Harbors Act of 1899	"
Protection of Wetlands E.O. 11990	"
Land and Water Conservation Fund Act	Not Applicable
Flood Plain Management E.O. 11988	Partial Compliance; requirement will be met upon review of EA
Wild and Scenic Rivers Act	Not Applicable
Clean Air Act	Partial Compliance; will be satisfied pending review of EA
Federal Water Project Recreation Act	"
Water Resource Planning Act of 1966	"
State and Local Policies	
Rhode Island CZM Program	Partial Compliance; requirement will be met when EA is reviewed.
Required Federal Entitlements	
Non Required	

List of Preparers
Bristol Harbor Navigation Improvement Study

Responsible Agency and Technical Consultants

The Impact Analysis Branch of the New England Division Army Corps of Engineers was responsible for preparing this Environmental Assessment. Technical assistance was provided under a contract to Normandeau Associates, Inc., of Bedford, New Hampshire which is a multi-disciplined firm of environmental specialists.

NED Staff

Project Manager - Mr. Steven Onysko, Coastal Development Branch, Civil Engineer had the overall responsibility for the preparation of the Plan Formulation Report and various breakwater designs and configurations considered.

Environmental Analysis - Mr. Gilbert Chase, Marine Resource Specialist, was in charge of the preparation of the EA and 404 Evaluation and day-to-day coordination of all environmental and technical work with the consultants.

Economic Analysis - Mr. John Barry was responsible for the collection and analysis of economic data.

Archaeologist - Mr. John Wilson, Division Archaeologist was responsible for the coordination and determination of proposed project plans on archaeological and cultural resources.

Environmental Consultant - Mr. Raymond Susnowski, Physical Oceanographer, Normandeau Associates, Inc., was responsible for the two-dimensional hydrographic mathamatical predictive model, dispersion simulation and wave data analysis relevant to the various breakwater plans.

SECTION 404 EVALUATION
PROPOSED BREAKWATER CONSTRUCTION
BRISTOL HARBOR, RHODE ISLAND

1. References.

a. Section 404(b) of Public Law 92-500, Federal Water Pollution Control Act.

b. 40 CFR 230.4 - 230.5 dated 5 September 1974.

c. EC 1105-2-90, Appendix C, dated 10 October 1978.

2. Proposed Project.

The selected plan of improvement, Plan B, consists of:

Provision for a 1700 foot breakwater detached from the eastern shore

Plan B is recommended on the basis of good flushing and adequate protection from wind waves generated along a southwest fetch. The trade-off for increased protection (larger breakwater) is restricted flushing which may have an effect on the marine biota and water quality. The length of this dog-leg structure depends on how much protection should be afforded to the industrial area around the town pier. If the need for protection is limited to the area between the town pier and the U.S. Coast Guard Station, then the breakwater could probably be shortened to 1200-1400 feet. The dog-leg configuration will provide better protection than an equivalent straight breakwater for this area. An opening of approximately 400 feet will exist between the breakwater and the eastern shore. This opening will facilitate flushing and circulation.

The exact method of construction of the breakwater is not yet known but may involve one or a combination of the following plans:

a. Displacement/penetration type of construction is feasible for the inner 600 feet of the breakwater where sediment probes indicate the average depth of soft foundation material to be two feet. By displacement it is meant that the rock for the breakwater upon dumping in place will force the soft muds downward and laterally until bottom resitence is met. No dredging would be involved with this method along this portion of the breakwater.

For the outer 1100 feet of the breakwater, the alternatives consist of:

a. Excavation of the soft overlying muds and its replacement with sand fill.

b. Placement of a 6-foot thick dumped sandfill blanket on the existing bottom (no dredging) followed six months later by construction.

Depending on the ultimate breakwater design selected, from 25,000 cubic yards to 42,000 cubic yards of bottom sediments may require excavation. Disposal of the material has been coordinated with town officials and the Rhode Island Coastal Resources Management Council. The Bristol Town Council has voted to approve of disposing the dredged materials in the town landfill (letters, 8, 11, & 17 June). The Coastal Resources Management Council has also recently (letter 15 June) informed the New England Division that efforts are underway to prepare a special area plan for the Brenton Reef dredged material disposal site. This site is envisioned as the State's open water regional disposal area.

3. Project Authorization.

The Bristol Harbor, Rhode Island navigation improvement project was authorized by Public Law 90-483, 90th Congress S 3710 August 13, 1968, Section 101 of the 1968 River and Harbor Act. Funds to initiate the Phase I, GDM Study were received in October 1978. The authorized project information is contained in H.D. 174/90 1st, and no EIS was required for the project at that time.

4. Environmental Concerns.

Effects of Breakwater on Currents and Circulation

The breakwaters each have the same general effect on upper harbor circulation while not affecting currents in the lower harbor. Eddies are formed north and south of each breakwater, their maximum speeds occur an hour before and after slack water with a relative minimum during slack water. During mid-ebb and mid-flood these eddies disorganized but soon after they reorganize in the reverse direction. Tidal heights are not significantly altered by the breakwater construction with an overall range difference of several centimeters.

The restrictive nature of the breakwater caused increased current speeds within and around the upper harbor. Although upper harbor circulation with the breakwaters will still be influenced by wind effects, the increased current speeds will help to insure harbor flushing.

Sediment Analysis

The sediment consists of organic silt with fines ranging between 50 and 91 percent. No detectable metals and pesticide concentrations were found in the EP toxicting test extracts. Only arsenic in location GE-3 was found in concentrations exceeding two standard deviations greater than the mean for other New England harbors located south of Cape Cod. Compliance of parameter values to bulk sediment chemical results from other harbors and cover in Narragansett Bay show that the range and mean values of Bristol Harbor, with the exception of arsenic, fall within the limits obtained for the other projects. The elutriate test data did not show any potential release of chemical parameters to the environment based in these test results. Thus material dredged from the proposed project area would appear suitable for open-water dumping.

230.4-1 PHYSICAL AND CHEMICAL BIOLOGICAL INTERACTIVE EFFECTS

(a) PHYSICAL EFFECTS

(1) Filling of Wetlands

The filling of wetlands is considered the most serious possible consequence of dredged material disposal. No filling of or disturbance to wetlands is involved in the proposed Bristol Harbor dredging, disposal operations or breakwater construction.

(2) Effects on the Water Column

The dredging and disposal activities, if undertaken, will cause temporary effects on the water column in the form of increased turbidity. This effect is expected to be limited in extent and of short duration. Full descriptions of these effects can be found in Section III Environmental Consequences. Use of the town landfill site would, of course, eliminate disposal impacts to the aquatic environment.

(3) Effects on Benthos

Benthic populations will be removed from the harbor in the area to be dredged. The dumping of a sand fill blanket to serve us a foundation for the breakwater would also smother living forms. The communities to be disturbed are very resilient and the area is expected to recover rapidly. The breakwater construction will result in a change in community structure from burrowing to attached biota. Further discussions of these effects are found in Section III.

(b) CHEMICAL-BIOLOGICAL INTERACTIVE EFFECTS

(1) Evaluation of Effects

The material to be disposed of is substantially clean silt and sand. Bulk chemical analysis and elutriate test were completed in accordances with the evaluation procedures in paragraphs 230.4(b)(2) and (3).

(2) Water Column Effects

Elutriate tests as required in this section showed no significant releases of potential contaminants.

(3) Effects on Benthos

Disposal options include an upland site which serves as the town landfill and open-water site off Brenton Reef. Ocean disposal will result in the smothering of the bottom benthic community and temporary disruption in the species population(s) functional activities.

230.4-2 WATER QUALITY CONSIDERATIONS

This section requires that the effects of the proposed dredging and disposal on applicable water quality standards be assessed. These effects, discussed in Section III, are expected to be limited in severity and of short duration. Comparison of these anticipated effects to the water quality standards of Rhode Island indicate that no permanent violation of standards is expected, nor does the action thwart the intention of existing water quality management plans.

230.5 SELECTION OF DISPOSAL SITE AND CONDITIONING OF DISCHARGES OF DREDGED OR FILL MATERIALS

(a) GENERAL CONSIDERATIONS AND OBJECTIVES

Consideration is to be given to the need for the action, the availability of alternative sites, and the effects of water quality standards. The need for the project is described fully in Section I. Alternative sites and methods of dredging and disposal are discussed in Section II. These discussions indicate that the proposed methods are equal or less damaging to the environment than are the alternatives.

(1) Avoid Disruption of Aquatic Ecosystems

As discussed in Section III, disruptions to aquatic ecosystems are expected to be limited in extent and recovery of the ecosystems is expected to be rapid.

(2) Avoid Disruption of Food Chains

No such effects are expected with the Bristol Harbor construction operations, including dredging and disposal.

(3) Avoid Disruption of Movement Patterns

The design and alignment of the breakwater will not conflict with the migratory movements of fish.

(4) Avoid Discharge in Wetlands

No discharge into wetlands is proposed.

(5) Avoid Discharge in Flood Retention Areas

No discharge into flood retention areas is proposed.

(6) Minimize Turbidity Levels

The proposed dredging and disposal plan will minimize turbidity and suspended materials.

(7) Minimize Degradation of Aesthetics, Recreation and Economic Environment

The dredging and disposal operations, if undertaken, will be scheduled so as to minimize aesthetic and recreation effects by limiting conflict with recreational boating. The economic effects of the project are positive. (See Sections I and III).

(8) Avoid Degradation of Water Quality

As discussed in Section III no serious or permanent effects to established water quality standards are expected.

(b) CONSIDERATIONS RELATING TO DEGRADATION OF WATER USES AT PROPOSED DISPOSAL SITE

(1) Municipal Water Supply Intakes

There are no intakes in the vicinity of the proposed construction site.

(2) Shellfish

The construction of the breakwater would eliminate approximately 4-5 acres of bottom shellfish habitat. The rock surfaces of the breakwater, however, will afford suitable habitat for the settlement and growth of mussels, the main shellfish beds located on the western side of the harbor will not be altered.

(3) Fisheries

No adverse effects to fisheries will occur.

(4) Wildlife

Disposal of the dredged materials, if at the landfill site will not result in the loss of upland habitat nor disturbance to wildlife.

(5) Recreation Activities

Fall or winter scheduling of dredging and disposal limits conflict with recreational boating activities and spawning of shellfish.

(6) Threatened and Endangered Species

No threatened or endangered species have been reported at the Bristol Harbor Site.

(7) Benthic Life

Temporary losses to the benthic community during dredging/disposal and breakwater construction will be rapidly made up through recolonization.

(8) Wetlands

No disposal in wetlands is proposed.

(9) Submerged Vegetation

Disposal at the sites being considered will not adversely affect aquatic vegetation.

5. Determinations and Findings

a. An ecological evaluation as required by Section 404(b)(1) of the Clean Water Act has been made following the evaluation guidance in 40 CFR 230.4, in conjunction with the evaluation considerations in 40 CFR 230.5. Appropriate measures have been identified and incorporated in the proposed plan to minimize adverse effects on the aquatic environment as a result of the discharge. Consideration has been given to the need of the proposed activity, the availability of alternative sites and methods of disposal that are less damaging to the environment, and such water quality standards as are appropriate and applicable by law. Impact on a minor wetland at the site would be unavoidable and approximately 4-5 acres of subtidal habitat would be eliminated. Reestablishment would occur on the breakwaters subtidal areas. Adverse impacts to the total marine ecosystem would not be significant. Activities associated with the proposed fill would be water oriented and water dependent. Construction during critical spawning periods and peak recreational boating would be avoided to minimize these impacts. A Public Notice with respect to the 404 Evaluation will be issued accompanying this decrement. Based on information presented in the 404 Evaluation and Environmental Assessment, I find that the project will not result in unacceptable impacts to the environment.

C. E. EDGAR, III
Colonel, Corps of Engineers
Commander and Division Engineer

FINDING OF NO SIGNIFICANT IMPACT

The recommended navigation improvement alternative at Bristol Harbor consists of a 1700-L.F. offshore dog-leg rock breakwater, located just south of the U. S. Coast Guard Pier, and a 1600-foot wide navigation opening on the west side of the harbor. Alternative methods of constructing the project include displacement of bottom materials "by end-dumping"; dredging of 25,000 to 40,000 cy of bottom material and its replacement with sandfill, ocean or land disposal; or placement of a 6-foot thick sand blanket under the outer section of breakwater.

The proposed project would provide Bristol Harbor with badly needed protection of Bristol Harbor from southerly storm waves and enhance future economic development.

The determination to prepare an Environmental Assessment, as opposed to an Environmental Impact Statement, was based on the following considerations:

- The Mathematical Hydrodynamic and Dispersion Prediction Model of the proposed breakwaters in Bristol Harbor indicated dispersion patterns similar to those without the breakwater.

- An analysis of the bottom material indicates that it would be suitable for either ocean or land disposal, if dredging is required.

- Construction of the rock breakwater would mitigate the removal of bottom shellfish habitat by providing hard surfaces for the attachment of various epifaunal invertebrates and habitat for fin fish, lobsters and mussel production.

- Environmental and social impacts would be minimal.

Coordination and consultation with appropriate Federal and State agencies insured that their concerns and recommendations were identified to the Corps so that they could be addressed during construction planning.

DATE

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

CONCLUSIONS

The alternative plans and all pertinent data concerning navigation and related improvements in Bristol Harbor have been reviewed and evaluated in the overall public interest.

It is concluded that there is a need to provide protection to Bristol Harbor from southerly storm waves originating in Narragansett Bay and an offshore rock breakwater designated as Plan B would best meet the planning objectives, the present and future needs of local interests, and enhance future economic development within Bristol Harbor as well.

RECOMMENDATIONS

It is recommended that the rock breakwater authorized by Public Law 90-483, 90th Congress S 3710 on August 13, 1968, Section 101 of the 1968 River and Harbor Act, in Bristol Rhode Island, be constructed in accordance with the modifications described in this report, and designated as Plan B.

The recommendation is made subject to the conditions that non-Federal interests will:

a. Make a cash contribution of 35 percent of the first cost of the construction of the breakwater, said contribution currently estimated at $2,040,850, and subject to final adjustment after actual costs have been determined.

b. Provide, without cost to the United States, all lands, easements, rights of way necessary for the construction and subsequence maintenance of the project when and as required, including suitable dredged material disposal areas with necessary retaining dikes, bulkheads and/or embankments if required. Rights of way should include access for a contractor and his equipment to construct the breakwater from land, if he exercises the option to do so.

c. Accomplish without cost to the United States, all alterations and/or relocations in sewer, water supply, drainage and other utility facilities, as required for the construction of the overall project.

d. Hold and save the United States free from damages that may result from construction and subsequent maintenance of the project.

e. Provide and maintain berths, floats, piers, and/or similar marina and mooring facilities as needed for transient and local vessels as well as necessary access roads, parking areas and other needed public use shore facilities open and available to all on equal terms. Only minimum, basic facilities and service are required as part of this project. The actual scope or extent of facilities and services provided over and above the required minimum is a matter of local decision. The manner of financing such facilities and services is a non-Federal responsiblity.

f. Establish regulatons prohibitng the discharge of untreated sewage, garbage, and other pollutants in the waters of the harbor, such regulations shall be in accordance with applicable laws or regulations of Federal, State and local authorities responsible for pollution prevention and control.

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

ACKNOWLEDGEMENT AND IDENTIFICATION OF PERSONNEL

This report was prepared under the general supervision of the following New England Division Personnel:

Colonel Max B. Scheider, Division Engineer (Retired Dec. 1980)
Colonel C. E. Edgar, III, Commander and Division Engineer
Joseph L. Ignazio, Chief, Planning Division
Donald Martin, Chief, Coastal Development Branch

The study was managed by Steven Onysko, P.E., Project Manager in the Coastal Development Branch. The Environmental Assessment was prepared by Gilbert L. Chase Jr., of the Impact Analysis Branch and the Economic Analysis was prepared by John J. Barry of the Economic and Social Analysis Section. Engineering analyses was performed by Anthony Mancini of the Coastal Engineering and Survey Section.

The New England Division is appreciative of the cooperation and assistance rendered during the course of the study by Personnel of other Federal and State Agencies, municipal and local authorities, and by concerned individuals, particularly the following:

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R.I. Division of Marine Fisheries.
R.I. Division of Environmental Management.
R.I. Coastal Resources Management Council.
Mrs. Sarah Amaral, Bristol Town Administrator
Gerhard Oswald, Bristol Town Planner
Joseph Cabral, Bristol Harbormaster
Bristol Town Council
Alan Guimond, Stonington Seafood Corporation
Arthur Beauregard, Chairman, Waterfront Improvement Committee.

BRISTOL HARBOR
BRISTOL, RHODE ISLAND

PHASE I AE&D

APPENDIX A

PROBLEM IDENTIFICATION

PREPARED BY THE
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

APPENDIX A

PROBLEM IDENTIFICATION

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PROBLEM IDENTIFICATION

SECTION A

ANALYSIS OF EXISTING CONDITIONS AND TRENDS

This Appendix contains information supplementing the first two sections of the Main Report, Introduction and Problem Identification, and documents previous studies and reports.

PRIOR STUDIES AND REPORTS

Federal interest in Bristol Harbor navigation improvements dates back to 1925 when local interests requested that the harbor be deepened to 30 feet. Subsequent requests included removal of the remains of a rock-filled pier, and the construction of a rock breakwater at the head of the harbor.

House Document No. 174/90th Congress/1st Session, authorized the construction of a 1600-foot offshore rock breakwater, but the project was not funded until October 1978. A Phase I AE&D Plan of Study indicated that the originally authorized project would still have a positive benefit/cost ratio and recommended that further detailed studies be undertaken to develop an optimum plan. A list of the reports and documents related to navigation improvements in Bristol Harbor and a brief description of each are shown in Table A-1.

LOCATION

Geographically, Bristol Harbor is located about 13 miles southeast of Providence, and about 12 miles north of Newport, Rhode Island, and 45 miles southwest of Boston, Massachusetts. It is on the east side and about half way up Narragansett Bay. The harbor is 2 miles long in a north-south direction and varies in width from 1.3 miles at the mouth to 0.4 miles at the head. Natural depths of 10 to 17 feet predominate throughout the harbor. Hog Island is located just outside the harbor and provides some protection from storm waves from the southerly quadrants. The existing, but uncompleted, authorized project is shown on Plate A-1.

The geographic study area includes the immediate harbor vicinity, from about the Coast Guard Pier northward. Anticipated impacts will, however, be generally discussed in the context of their effects on the economics of Bristol County and the State of Rhode Island.

TABLE A-1
SUMMARY OF PRIOR STUDIES AND REPORTS

Published In	Nature of Report	Recommendations
Unpublished Dec 1925	Deepen Harbor to 30 ft.	Harbor depth considered adequate for present and anticipated future use.
Unpublished Dec 1927	Removal of remains of rock-filled pile considered hazard to navigation.	Removal not warranted as marking of obstructions would be adequate.
Dec 1966 (Revised March 1977)	Review Reports on Bristol to determine navigation improvements needed.	Recommended construction of a 1600 L.F. offshore rock breakwater.
H. Doc. No. 174 90th Cong., 1st Session, 1967.	Survey.........	Authorized construction of 1600 L.F. offshore rock breakwater (not funded).
Dec 1979	Phase I AE&D Plan of Study	Recommended further study of offshore breakwater to comply with BERH request to develop optimum plan.

EXISTING CONDITIONS

Geologically, Narragansett Bay represents a transgression by the Atlantic Ocean over the southern part of an area of exposure of metamorphosed sedimentary rocks known as the Narragansett Basin. The area is a negative relief feature, because of differential erosion of carboniferous rocks, flaking granites, gneisses and schists, during the early and late Wisconsin Glacial periods.

If it were not for the more resistant rock on the promontories within Narragansett Bay, the ocean would have caused the shoreline to retreat to a greater extent and the configuration would be vastly different than it is today.

A prominent submarine gorge, attaining depths of over 200 feet at its southerly end, runs from the mouth of Mount Hope Bay, along the easterly shores of Prudence and Jamestown Islands and becomes a shoal at a general 80-foot sea bottom depth, just off the Newport headland. This apparent scour trench and the adjacent Bristol Harbor have filled with sediments to varying depths since the last glaciation period of abut 10,000 years ago.

The shoreline of Bristol Harbor shows evidence of glacial deposits and rock outcrops, as well as erosion and accretion from waves originating in Narragansett Bay.

Bristol has a long history of marine-oriented enterprises. Ships were built for the rum-molasses-slave trade and a large whaling fleet was based in Bristol Harbor before and after the revolution.

Bristol Harbor was one of the major ports in Narragansett Bay for foreign commerce, particularly the China Trade, from after the revolution to until about 1840. Petroleum products replaced whaling in the 1860's and ship owners turned to coastal freighting and passenger services and the merchants who had underwritten maritime commerce were shifting their financial backing to industry.

Over the years, the east shore of the harbor developed into textile and recreational boat building enterprises, as well as other types of manufacturing. The textiles and recreational boat building gave wave to a mix of commercial, residential and some recreational uses of the shoreline as well as commercial shell fishing. The harbor's west shoreline is occupied by several large private estates, The Bristol Yacht Club and the Bristol Marine Boat Yard.

There are about 250 moorings in Bristol Harbor, which accommodate mostly recreational boats. Other boating interests include the Prudence Island Ferry, U.S. Coast Guard ships and boats, and a few small commercial fishing boats, as well as numerous commercial shellfish boats. Two town-owned public landings are located at the dock at Rockwell Park and the State Street dock. The Church Street dock, which is also the town marina, is leased from the State on a long term basis, as is the Independence Park area, which also has a launching ramp.

Dock and slip space is filled and the trend is for a number of commercial shell fishermen to trailer their boats to and from their homes. Expansion in recreational boating has almost stopped, due to the lack of protection and shore facilities. The trend in recreational boating is to change from power boats to sail and upgrade from sail to larger sailing craft.

PROBLEMS, NEEDS AND OPPORTUNITIES

The problems, needs and opportunities within the study area are directly related to the exposure of the open harbor to storm waves from southerly quadrants. Existing navigation facilities throughout the harbor are inadequate to safely and economically accommodate the existing and prospective commercial and recreational fleets and shoreline structures without storm wave protection.

PROBLEMS

The problems within Bristol Harbor may be summarized as continual damages to boats and shoreline structures, due to the lack of protection from storm waves into the harbor from Narragansett Bay.

NEEDS

The needs of the community as determined through the identification of the problems are evident. A protected harbor is needed to prevent continual damages and provide the opportunity for economic growth in marine-oriented enterprises.

OPPORTUNITIES

Improvements in Bristol Harbor can be accomplished by construction of a fixed breakwater in the upper limits of the harbor. The breakwater will provide the opportunity to contribute to the protection of the existing recreational boating fleet, as well as boats that will utilize the harbor in the future; reduce hazards associated with unloading commercial shellfish boats and maneuvering of the ferry; prevent damages to the U.S. Coast Guard pier and commercial/industrial areas along the east shore; reduce wave heights within the upper harbor and reduce boarding hazards of the moored boats; and provide the opportunity to construct marina-type facilities and replace dock structures that were previously destroyed by storm waves at the Castle Restaurant and Elks Club.

SECTION B

PLANNING OBJECTIVES AND CONSTRAINTS

NATIONAL OBJECTIVES

Planning for navigation improvements in Bristol Harbor is based in part on national objectives of economic development and enhancement of environmental quality. In 1973, the Water Resources Council published Principles and Standards for Planning Water and Related Land Resources which provide the broad policy framework for planning activities. The Standards provide for uniformity and consistency in comparing, measuring and judging the beneficial and adverse effects of alternative water resource improvement projects. The purpose of the Principles and Standards is to promote the quality of life by planning for the attainment of the following objectives:

> To enhance national development by increasing the value of the nation's output of goods and services and improving national economic efficiency.
>
> To enhance the quality of the environment by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural resources, cultural resources and ecological systems.

These are termed National Economic Development (NED) and Environmental Quality (EQ) objectives. The NED and EQ objectives were fully considered in developing and evaluating the alternative improvement plans.

PLANNING OBJECTIVES

The planning objectives are to provide storm wave protection for Bristol Harbor, to eliminate the problems of navigation safety and damages to boats and shoreline structures, and to provide the opportunity for local interests to contribute to the overall economy by providing additional facilities and safely utilizing the resources in the area.

PLANNING CONSTRAINTS

Planning constraints are those items which can specify limitations that are used to direct plan formulation and restrict or mimimize adverse impacts. Such impacts may affect a wide range of different concerns, including natural conditions within the project site, technological states of the art, economic limits and legal restrictions. The identified possible constraints are as follows:

a. Local interests may not be able to provide their share of the cost of construction of the proposed breakwater.

b. Lands, easements and rights of way may not be readily available and Eminent Domain proceedings may be uneconomical and time consuming.

c. Suitable spoil disposal sites for dredged materials may not be available at the time of construction and may prohibit construction for an indefinite period.

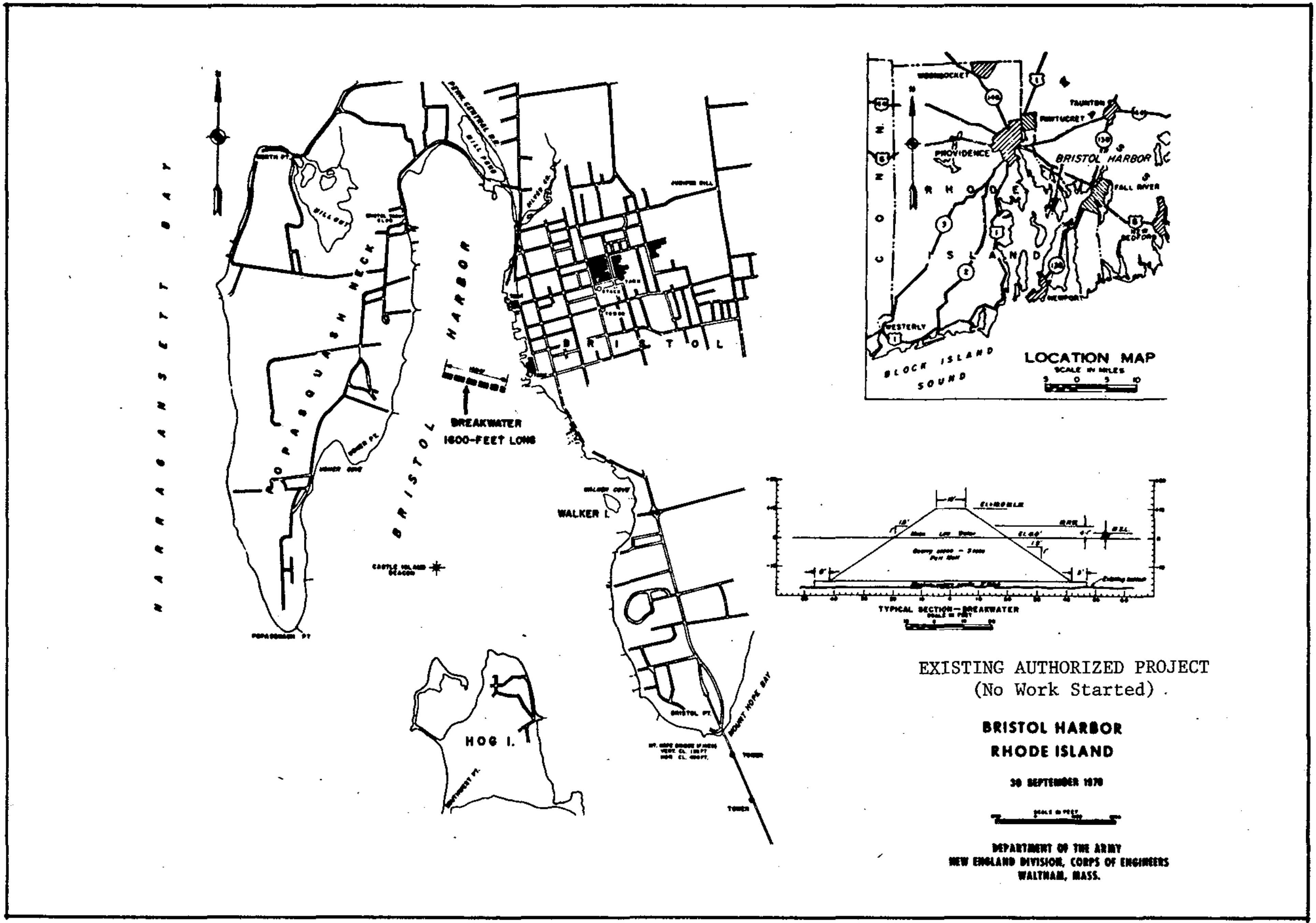
NARRAGANSETT BAY
POPASQUASH NECK
BRISTOL HARBOR
BRISTOL
BREAKWATER
1600-FEET LONG
WALKER I.
HOG I.
MOUNT HOPE BAY
WOONSOCKET
PAWTUCKET
TAUNTON
PROVIDENCE
BRISTOL HARBOR
FALL RIVER
NEW BEDFORD
NEWPORT
WESTERLY
CONN
RHODE ISLAND
BLOCK ISLAND SOUND
LOCATION MAP
SCALE IN MILES
TYPICAL SECTION—BREAKWATER
EXISTING AUTHORIZED PROJECT
(No Work Started)
BRISTOL HARBOR
RHODE ISLAND
30 SEPTEMBER 1970
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

PLATE A-1

BRISTOL HARBOR

BRISTOL, RHODE ISLAND

PHASE I AE&D

APPENDIX B

FORMULATION, ASSESSMENT AND EVALUATION OF DETAILED PLANS

PREPARED BY THE
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

APPENDIX B
FORMULATION, ASSESSMENT AND EVALUATION OF DETAILED PLANS

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LIST OF TABLES

APPENDIX B

FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS

SECTION A

FORMULATION AND EVALUATION CRITERIA

The formulation of a plan of improvement for Bristol Harbor has followed the procedures of the Water Resources Council Principles and Standards. Local needs and objectives were identified and project-specific planning and opportunity statements were established. These planning and opportunity statements were considered in the formulation of detailed plans, as were the national objectives of National Economic Development (NED) and Environmental Quality (EQ).

Detailed technical, economic and environmental criteria were applied in the formulation and evaluation of the alternative plans. These criteria reflect quantitative measures of the plan performance in relation to the national and local planning objectives and planning constraints. These criteria, which are described below, are utilized in the System of Accounts to evaluate the three alternative detailed plans.

TECHNICAL CRITERIA

The technical criteria are as follows:

- The selected plan should provide the maximum economical amount of protection from the frdihn storm wave, from southerly quadrants.

- The selected plan should provide for adequate safe anchorage areas accommodate the numbers and types of craft expected to use the harbor.

ECONOMIC CRITERIA

The economic criterion is as follows:

- Maximize net benefits (project benefits minus project costs).

ENVIRONMENTAL CRITERIA

The environmental criteria are as follows:

- Minimize volume of dredge material in order to reduce problems relating to disposal of dredged material.

- Minimize and mitigate removal of bottom shellfish habitat.

SOCIAL AND CULTURAL CRITERIA

The social and cultural criteria are as follows:

- Maximize safety and ease of navigation for all craft utilizing the harbor.

- Maximize the cultural and aesthetic value to the harbor and any structures constructed.

- Contribute to the economic development of the Bristol Harbor area.

SECTION B

DEVELOPMENT OF MANAGEMENT MEASURES

Management measures take into consideration the problems, needs and opportunities of the study area, and take into account one or more of the objectives set forth in Sections A and B of Appendix A. Management measures can be generally categorized as either structural or nonstructural in nature.

Structural management measures include the following:

(1) Fixed breakwater structures of rock, steel, or concrete to protect selected areas.

(2) Floating breakwaters of rubber tires, concrete, steel or aluminum to protect selected areas.

(3) Hurricane barrier to protect the entire harbor.

Nonstructural management measures are those that achieve the stated planning objectives by means of other than physical structures, and/or modification or replacement of existing facilities or structures. Nonstructural plans considered for Bristol Harbor fall into the following four general categories:

(1) Reduction of Boat Damages. Damages could be reduced by strengthening the mooring lines and moorings; moving the boats to a more sheltered harbor in times of approaching bad weather; and removing the boats from the water prior to the start of the hurricane season in mid-August.

(2) Reduction of Shoreline Damages. Damages to shoreline property could be reduced by repairing or modifying existing docks and piers or replacing structures with steel bulkheads or rock revetment. Removing structures altogether would eliminate a source of deteriorating shoreline damages. Zoning would prohibit building in floodprone areas and prevent future damages.

(3) Increase of Recreational Boating Potential. Construction of additional boat launching ramps separately or in conjunction with "dry" stacking of boats would increase the potential use of the harbor by recreational boats. A floating breakwater at the launching site would allow launching of boats during marginal weather and provide a sheltered area for additional moorings.

(4) Flood Insurance. Reduction of damages to coastal buildings could be ameliorated by the federally sponsored Flood Insurance Program, however, the insurance is not applicable to wave damages of shoreline docks, piers, bulkheads or seawalls.

Although the above measures are categorized as nonstructural, they would require some kind of structural modifications and construction activity. Non-Federal interests would be responsible for the implementation of nonstructural methods.

ASSESSMENT AND EVALUATION OF MANAGEMENT MEASURES

Structural measures were determined to be the most practicable method of providing protection to Bristol Harbor and were considered for more detailed studies.

Nonstructural methods were determined to be impractical and were not considered for more detailed study for the following reason:

(1) Most of the harbors in Narragansett Bay, within a reasonable sailing distance from Bristol Harbor, also have southerly exposures and it would be unwise to move the boats into similar weather conditions. Removing the boats from the water prior to the hurricane season would shorten the recreational boating season by at least six weeks and would deprive the owners of the use of their boats during that time.

(2) Repair and/or replacement of shoreline structures is expensive and may be beyond economic repair or cannot be financed by the present owners. Owners are reluctant to remove the structures due to costs involved and have no incentive to do either of the above. Zoning would not affect the existing structures.

(3) There is presently no demand for "dry" stacking of boats or additional boat launching ramps due to the absence of adequate harbor protection and the lack of incentive to provide the facilities.

(4) Flood insurance will not prevent damages and this method would not fulfill the planning objectives.

SECTION C

COMPARISON OF DETAILED PLANS

In comparing the proposed detailed plans it is noted that many do not fully comply with standards set forth under Principles and Standards. Therefore a tradeoff analysis was performed to determine the most economical plan of improvement for further study. It was determined that the breakwater plans were the most practical and economical and had the least impact on the environment.

Plan A - This originally authorized plan satisfies the planning objectives and provides protection to the harbor, but does not provide protection to the U.S. Coast Guard pier or a portion of the commercial/-industrial shorefront. This plan is the least expensive and provides minimum benefits of the three plans. The water quality impacts for all breakwater plans will be the same.

Plan B - This dogleg breakwater plan would provide protection to the harbor, U.S. Coast Guard pier and the commercial/industrial area, unlike Plan A. The benefits for this plan are greater than for Plan A but less than Plan C. The cost is slightly higher than Plan A but the net benefits are greater.

Plan C - This plan is an addition to Plan B and will provide harbor protection and protect the U.S. Coast Guard pier and the commercial/industrial area. It will also provide protection to the Bristol Yacht Club and Marine Boat Yard. This plan is the most expensive of the three plans and provides maximum benefits of all the breakwater plans. It also has the lowest benefit-to-cost ratio when compared to Plans A and B.

SYSTEM OF ACCOUNTS

The System of Accounts is a summary evaluation required by the Principles and Standards. The System of Accounts provides in a concise format an evaluation of the alternative plans in terms of the national objectives of National Economic Development (NED), Environmental Quality (EQ), and the national accounts of Social Well-Being (SWB) and Regional Development (RD). It also demonstrates plan performance in terms of the planning objectives and constraints; the technical, economic, and other criteria; and other measures such as plan acceptability.

The System of Accounts is shown in Table B-1. The summary assessments indicate that the plans have varying responses to the different national objectives and accounts. In evaluating all impacts considered, Plan B is shown to be the most favorable option considered.

TABLE B-1

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
A. PLAN DESCRIPTION	1600-ft. offshore rock breakwater beginning 400′ west of the Coast Guard Pier & extending in a northwest direction.	1700-ft. offshore, dog-leg rock breakwater, beginning 400′ from the east shore & 300′ south of the coast guard pier, then extending northwesterly.	1700 ft. offshore, dog-leg rock breakwater, beginning 400′ from the east shore & 300′ south of the coast guard pier, and an additional 700 ft. rock breakwater extending from the westerly shore in an easterly direction.
B. IMPACT ASSESSMENT			
NATIONAL ECONOMIC DEVELOPMENT			
Project Cost	\$5,654,000	\$5,837,500	\$7,920,500
Average Annual Benefits	\$729,000	\$772,000	\$1,040,000
Average Annual Costs	\$258,000	\$251,000	\$341,000
New Benefits	\$471,000	\$522,000	\$663,000
Benefit-Cost Ratio	2.83	3.08	2.94

TABLE B-1 (Cont'd)

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
ENVIRONMENTAL QUALITY			
WATER QUALITY			
Turbidity at Dredge Site	Yes	Yes	Yes
Effluent Discharge at Dredge Site	Yes	Yes	Yes
Disposal Promotes Leaching of Effluent into Tidal Lands	No	No	No
Dredging Impacts on Water Quality	Temporary	Temporary	Temporary
Breakwater Interferes with Tidal Currents	Minimal	Minimal	Slight Increase
Breakwater Decreases Water Quality	No	No	No
Affect of Breakwater on Flushing Patterns	Adequate	Best	Worse
AIR QUALITY			
Increased Fuel Emissions from Vessels and Vehicles	Yes	Yes	Yes
Short Term Dust Conditions at Disposal Site	Yes	Yes	Yes
Dust and Noise at Dredging Area	Yes	Yes	Yes
Short Term Marine Odor During Dredging Operations	Yes	Yes	Yes

TABLE B-1 (Cont'd)

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
LAND USE (Present)			
Wetlands Lost	None	None	None
Commercial Land Use Disrupted	None	None	None
Residential Land Lost	None	None	None
Sufficient Land for Land Disposal	Yes	Yes	Yes
Recreational Land Lost	None	None	None
Wildlife Area Lost	None	None	None
PLANTS			
Terrestrial Vegetation Destroyed	None	None	None
Aquatic Vegetation Destroyed	None	None	None
ANIMALS			
Wildlife Displaced	No	No	No
Wildlife Destroyed	No	No	No
Benthic Fauna Destroyed	Yes	Yes	Yes
Temporary Disruption of Fish Habitat	Yes	Yes	Yes
Permanent Loss of Shellfish Habitat	Yes	Yes	Yes
Mitigation of Shellfish Loss	Yes	Yes	Yes
SOCIAL WELL BEING			
Encourages a Diversified Base through New Industrial Development	Yes	Yes	Yes

TABLE B-1 (Cont'd)

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
Decreases Risk of Vessel Collision	Yes	Yes	Yes
Short Term Disruption of Vehicular Traffic	Yes	Yes	Yes
Concentration of Heavy Equipment Increases Potential Hazard to Health and Safety During Construction	Yes	Yes	Yes
Overall Navigation Project will Require Local Labor	No	No	No
Related Development of Facilities Will Require Local Labor	Yes	Yes	Yes
Industrial, Commercial, and Residential Relocation Necessary	No	No	No
Disrupts Commercial Business Activities	Short Term	Short Term	Short Term
Disrupts Recreational Activities	Yes Short Term	Yes Short Term	Yes Short Term
Related Commercial Development will Increase Tax Revenues	Yes	Yes	Yes
Large Local Investment Required to Develop Related Commercial Facilities	Yes	Yes	Yes
Disrupts or Overextends Police and Fire Protection	No	No	No
<u>REGIONAL DEVELOPMENT</u>			
Supports Industrial and Commercial Growth	Yes	Yes	Yes

TABLE B-1 (Cont´d)

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
Provides Service and Maintenance Facilities	No	No	No
Majority of Construction Labor for Basic Project Hired Locally	Yes	Yes	Yes
Construction Expenses Would Increase Local Income Through Secondary and Induced Economic Activity	Yes	Yes	Yes
Non-Federal Government Funds Required for Implementation of Portion of Project	Yes	Yes	Yes
Disrupts Commercial Production During Implementation	Minimum	Minimum	Minimum

C. PLAN EVALUATION

VISUAL APPEARANCE

Loss of Aesthetics	Minimum	Minimum	Minimum
Increase Vehicle Activity In Existing Area	Yes	Yes	Yes
Archeological and Historical Value Lost	None	None	None

TABLE B-1 (Cont'd)

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
ACHIEVES OBJECTIVES			
Protects Boats	Yes	Yes	Yes
Protects Shoreline	Yes	Yes	Yes
Provides Opportunity for Expansion	Yes	Yes	Yes
Improves Navigation Safety	Yes	Yes	Yes
D. PUBLIC RESPONSE			
GENERAL ACCEPTANCE			
Plan is Acceptable by Town Officials	Yes	Preferred	Yes
Plan is Acceptable to Private Concerns	Yes	Preferred	Yes
Plan Compliments Redevelopment Plans of the Town	Yes	Preferred	Yes
E. IMPLEMENTATION RESPONSIBILITIES			
COST SHARING			
Federal	$3,451,280 (61%)	$3,796,500 (65%)	$4,914,320 (62%)
Non-Federal	$2,202,710 (39%)	$2,040,850 (35%)	$3,006,180 (38%)
Project Costs	$5,654,000 (100%)	$5,837,500 (100%)	$7,920,500 (100%)

BRISTOL HARBOR

BRISTOL, RHODE ISLAND

PHASE I AE&D

APPENDIX C

PUBLIC VIEWS AND RESPONSES

PREPARED BY
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

APPENDIX C

PUBLIC VIEWS AND RESPONSES

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United States Senate

COMMITTEE ON HUMAN RESOURCES

WASHINGTON, D.C. 20510

December 18, 1978

Colonel John P. Chandler
Division Engineer
New England Division, Corps of Engineers
Department of the Army
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Chandler:

I have received a request from the office of Mrs. Sarah Amaral, the Town Administrator for the Town of Bristol, Rhode Island with regard to repairs to a breakwater in that community.

Recent storms have caused boulders along the waterfront to slip into Bristol Harbor. The Town of Bristol lacks the equipment required to put the boulders back into place, and would be interested in obtaining the necessary equipment from the Corps of Engineers.

I would appreciate your reviewing this matter and taking whatever steps are necessary to fulfill this request. Mrs. Amaral may be contacted at the following address:

The Honorable Sarah Amaral, Administrator
Town of Bristol
Town Hall
Bristol, Rhode Island 02809
Telephone: (401) 253-7000

Thank you for your consideration.

Sincerely,

John H. Chafee

John H. Chafee
United States Senator

JHC:dg

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDPL-C

14 February 1979

ANNOUNCEMENT OF THE INITIATION
OF
PHASE I GENERAL DESIGN MEMORANDUM
FOR
AUTHORIZED NAVIGATION IMPROVEMENT
IN
BRISTOL HARBOR, RHODE ISLAND

The Division Engineer, United States Army Corps of Engineers, New England Division, has initiated the Phase I General Design Memorandum for construction of a rock breakwater in Bristol Harbor, Rhode Island.

The navigation improvement was authorized by Public Law 90-483, Section 101 of the River and Harbor Act of August 13, 1968. Funds to prepare the design memorandum were allocated on 1 October 1978.

The project provides for a rock breakwater 1600 feet long, with a top width of 10 feet at elevation 10 feet above MLW, and side slopes of 1.5 to 1.0. It will be located at the head of the harbor and begin about 400 feet west of the Coast Guard pier, then extend generally in a northwesterly direction. It will not be connected to either shore. A copy of the project map is inclosed.

The breakwater was considered to be the most feasible and economical improvement for Bristol Harbor and would substantially reduce the exposure of the harbor to storms originating in southerly quadrants.

The benefits to be derived from the improvement are general in nature and will accrue to both commercial and recreational boating interests. Commercial benefits include reduction in costs to fishing boat owners for landing their catch and reductions in boat damages from storms. Recreational boating benefits include increased use of the protected harbor, additions to the fleet and reduction in boat damages.

Phase I includes an overall review of the authorized project, with a view to substantiate the present need, and also to up-date estimated costs and benefits as well as to determine if local interests still desire to participate in the construction of the project.

This announcement is being sent to you and other persons and agencies known to be interested in this matter, to solicit information and/or comments that might be useful in expediting the overall review. If you have any pertinent information you think will be useful please submit it to:

Division Engineer
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham, MA 02154

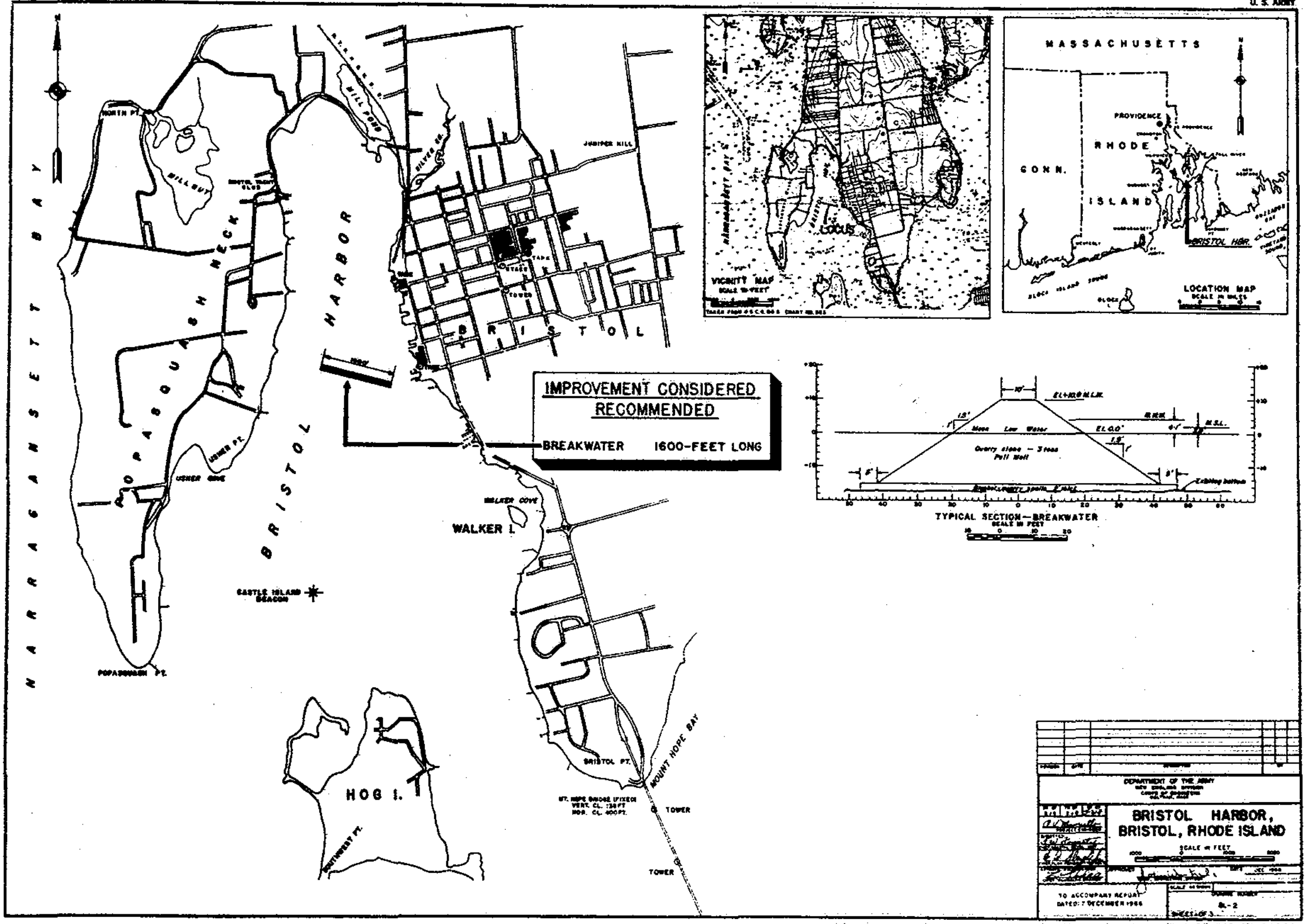
Please bring this announcement to the attention of anyone you know to be interested in this matter.

Max B. Scheider
MAX B. SCHEIDER
Colonel, Corps of Engineers
Acting Division Engineer

1 Incls.
as stated

CORPS OF ENGINEERS

U. S. ARMY



C-4

PLATE-1

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. Box 1518
Concord, New Hampshire 03301

Refer to: NED-P

JUL 11 1979

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

This is our fish and wildlife report concerning the proposed navigation improvements in Bristol Harbor, Bristol County, Rhode Island. The project was authorized by Public Law 90-483, Section 101 of the Rivers and Harbors Act of August 13, 1968. This report is authorized by the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and was prepared in coordination with the National Marine Fisheries Service and the Rhode Island Division of Fish and Wildlife. This report supersedes our report dated October 20, 1961. We understand there may be further changes in this project, which will require a supplement to this report.

Bristol Harbor is located at the northeast side of Narragansett Bay about 13 miles southeast of Providence, Rhode Island. The Town of Bristol lies on the east side of the Harbor which is about 1,000 acres in extent. The harbor is about a mile wide at the entrance and two miles long.

There is no existing Federal project in this natural harbor. The purpose of the proposed project is to protect boats from storm waves that enter from a southerly direction.

The proposal consists of constructing a stone breakwater about one mile north of Hog Island to protect about one-half the harbor area. The design being considered is 1,600 feet long with a top elevation 10 feet above mean low water and a top width of 10 feet. The east end of the breakwater would lie about 400 feet west of the Coast Guard Station and it would extend westward ending about 1,000 feet from the west shore. Side slopes would be 1.5 to 1 and the bottom width would be 94 feet and the water is 15 to 20 feet deep at this site.

A major commercial activity in Bristol Harbor is the landing of lobsters and hard clams for the restaurant trade. Of the three companies involved in the shellfish and finfish trade only one is a wholesale outlet. The other two use products in their own restaurants. Large numbers of recreational craft, other commercial vessels, a ferry line, and the U.S. Coast Guard also use the harbor.

JUL 16 1979

Hard clams are the principal benthic resource of Bristol Harbor. Several species of finfish including winter flounder, present during the spring and fall, young mackerel and bluefish, scup, and tautog constitute the sportfish resource. Several species of waterfowl including scaup and Canada geese spend part of the winter in the harbor.

The base of the breakwater will cover about 4 acres of bottom habitat. Replacement of the loss of much of the benthic productivity will occur as the breakwater becomes colonized by attached and clinging organisms at subtidal and intertidal elevations. The hard clam would not be expected to colonize on the breakwater. Therefore, construction of the breakwater will cause the loss of about 4 acres of habitat for this species.

Construction of the breakwater could cause changes in water circulation through the harbor. The potential adverse impacts of such changes could be magnified if there is a reduction in the flushing rate. This would tend to increase impacts of pollution on the benthic and free swimming biota, but this could be offset by future pollution abatement.

Waterfowl wintering in the harbor may benefit through added protection from wind and high waves.

A survey of quahog resources was made at nine sampling stations in March 1979. Populations of quahogs were very high in the area immediately south of the east end of the proposed breakwater. This area is closed to shell-fishing because of pollution. There were few quahogs west of the pollution line in the vicinity of the proposed breakwater. This area is open to shellfishing and fishing pressure may be keeping populations low. It is expected that loss of habitat for quahogs will not be significant.

The greatest feasible exposure of surface area should be incorporated into the breakwater to achieve maximum productivity of attached organisms, and maximum interstitial development which would be used as shelter by fish, crabs, and snails.

The breakwater will attract sport fish species because it will provide a food source for smaller fish. As a result the breakwater will attract fishermen. There will be adequate opportunity for fishermen to fish from boats anchored around the breakwater. Therefore, there will be no need to provide access ladders or berms on the breakwater.

We understand that an alternate site for the breakwater is being considered. This would consist of a breakwater attached to the shore. Such a breakwater would offer opportunities for sportfishing if certain conditions are met. Public access, a parking area, and safe walking surfaces on the breakwater would be required to achieve sportfishing benefits. We estimate that there would be an average of at least 3,000 fisherman days per year of use (based on an assumed 1,000-foot fishable length) with an average annual equivalent value of about $5,300. More specific data can be provided when we receive the final plans for the alternate breakwaters.

All quahogs in the eastern section of the project site should be removed from the work area prior to construction. This would avoid the loss of the existing resource. The shellfish could be returned to other sites in the polluted zone where they would continue to serve as a seed source for the bay.

We recommend that:

1. The breakwater be designed and constructed so as to expose the greatest surface area and interstitial development at subtidal and tidal elevations.

2. Quahogs be moved away from the work area before construction starts.

Sincerely yours,

Gordon E Beckett

Gordon E. Beckett
Supervisor

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
COMMANDER (oan)
FIRST COAST GUARD DISTRICT
150 CAUSEWAY STREET
BOSTON, MA 02114
Tel: 617-223-3632

16530
[illegible]

From: Commander, First Coast Guard District
To : Division Engineer, New England Division, Army Corps of Engineers

Subj: Navigation Study, Bristol Harbor, Rhode Island

Ref : (a) Your letter of 20 DEC 79

1. After reviewing reference (a), PLAN B is our preferred alternative. It least restricts the manneverability of Coast Guard vessels entering and leaving Bristol Harbor. PLAN C is our next preferred alternative and PLAN A is our least desired alternative since it would be the most restrictive to our vessels.

2. With the adoption of PLAN B or C, the Bristol Coast Guard pier must be extended approximately 250 LF to retain present vessel mooring capability. This extension is estimated to cost $750K and is beyond the Coast Guard's funding capabilities. Therefore, it is requested that the extension of our pier be included in the Corps of Engineer's project for breakwater construction.

T. P. SCHAEFER
By direction

Copy: CCGDONE (ecv)

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Environmental Management
DIVISION OF PLANNING AND DEVELOPMENT
83 Park Street
Providence, R. I. 02903

March 11, 1980

Mr. Joseph L. Ignazio
Chief, Planning Division
Department of the Army
N.E. Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

RE: NEDPL-C, BRISTOL HARBOR BREAKWATER

Dear Mr. Ignazio:

At your request, the Department of Environmental Management has reviewed the alternative plans for the subject project and has the following comments:

1. The Bristol wastewater treatment facility outfall is located to the southwest of Walker Island and, in the opinion of the Division of Water Resources, will not impact the area of the proposed breakwater.

2. There is a sewage pumping station overflow at the foot of Constitution Street which could discharge raw sewage in the event of pump or electrical failure. Because of this and the normal pollution effects of urban runoff, it is recommended that culverts be installed in the 600 foot shoreward section of the breakwater in Plan B and Plan C to allow for tidal exchange in this area (note, this recommendation should be considered part of the hydrological study in #4).

3. The Division of Fish & Wildlife has indicated the following resources and use in the area:

    a. The R.I. Shellfish Atlas indicates that beds of hard-shell clams (Mercenaria mercenaria) exists in the harbor. The freshwater fisheries section has no records of anadromous fish runs in Bristol Harbor, and the Wildlife Section reports no significant waterfowl populations which could be effected by the proposal.

b. There is intensive use of the harbor by both commercial fishermen and recreational boaters. A number of commercial fishing boats are moored at the town pier and adjacent areas. The water quality of the western half of Bristol Harbor is designated SA, but the eastern half is designated SB and closed to shellfishing.

4. Construction of the proposal breakwater may encourage the lateral growth of existing salt marshes by decreasing wave activity. At this time, it appears that the major environmental considerations associated with all three alternatives are changes in tidal flushing patterns which may cause a decrease in water quality and blockage of the harbor entrance by encouraging the accumulation of ice floes; therefore, it is recommended that a comprehensive hydrological study be conducted to evaluate these potential impacts.

5. The Division of Coastal Resources has raised the following points:

a. Local cost of 2.4 million dollars would seem prohibitive. We do not know that the Town of Bristol has even indicated willingness to participate. In 1977, the local cost was $1.5 million.

b. It is questionable that cost would offset any benefit accruing to commercial or recreational boating.

c. Plans as presented are very preliminary but would seem to restrict access to the harbor.

d. Final construction plans of the breakwater would require full review and assent from the CRMC.

e. Installation of a breakwater is not in conflict with the Coastal Program and would generally seem acceptable as the benefit denied from its installation would accrue to the public in general.

In general, the Department's major concerns are the flushing action and need for the project. Our office will be happy to work with you on the scoping of any study related to this project. If you have any questions, please contact me at (401) 277-2777.

Very truly yours,

Victor Alan Bell

Victor Bell
Senior Planner

VB:lmd

cc W. Edward Wood
R. Bendick
J. Cronan
J. Beattie
J. Fester

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
COMMANDER (oan)
FIRST COAST GUARD DISTRICT
150 CAUSEWAY STREET
BOSTON, MA 02114
Tel: 617-223-3632

16530
APR 11 1980

From: Commander, First Coast Guard District
To : Chief, Planning Division, New England Division, Corps of Engineers

Subj: Navigation Study, Bristol, Rhode Island

Ref : (a) Your ltr NEDPL-C dtd 19 MAR 80

1. Plan D, as expressed in reference (a) is acceptable to the Coast Guard if the clearance is adequate for the manueverability of our vessels.

2. The three boat width clearances in your letter is understood to equal 111 feet (based on the 37 foot beam of our 180' class buoy tenders).

3. We believe that a minimum clearance of 200 feet is mandatory for safe maneuvering.

T. P. SCHAEFER
By direction

Copy: CCGDONE (ecv) w/copy of Ref. (a)

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Environmental & Technical Services Division
Environmental Assessment Branch
7 Pleasant Street
Gloucester, Massachusetts 01930

April 22, 1980

Col. Max B. Scheider
Division Engineer
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Scheider:

This is in reference to Mr. Ignazio's letter dated January 4, 1980, concerning the proposed breakwater in Bristol Harbor, Rhode Island. This letter represents a preliminary statement of National Marine Fisheries Service (NMFS) concerns. A more detailed response will be sent upon receipt of your Phase I Report.

It is our understanding that parts of Bristol Harbor are utilized as a commercial fishery for surf clams (Mercenaria mercenaria). Adverse impacts upon the resources supporting this fishery would result in reduced harvests and would be of concern to local fishermen.

The NMFS is also concerned that the presence of the breakwater may alter the current regime in Bristol Harbor and produce stagnant areas which will be detrimental to existing resources. We recommend that this aspect of the three plans presented in Mr. Ignazio's letter be thoroughly studied, and that the results of this study be presented in the Phase I Report.

We appreciate the opportunity to comment during early planning stages of such projects, and believe such coordination will result in the most optimally acceptable project.

Sincerely,

Ruth Rehfus

Ruth Rehfus
Acting Branch Chief

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

HISTORICAL PRESERVATION COMMISSION
Old State House
150 Benefit Street
Providence, R. I. 02903
(401) 277-2678

June 23, 1980

Mr. Joseph L. Ignazio
Chief, Planning Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

RE: Reconnaissance Study, Bristol Harbor, Bristol, Rhode Island

Dear Mr. Ignazio:

This Commission has reviewed the preliminary alternatives for a proposed offshore breakwater to be constructed in Bristol Harbor, identified in your letter of June 5, 1980 as Plans A, B, and C.

We are enclosing for your information two xerox copies of the two National Register districts which will be affected by these proposals. The Bristol Waterfront Historic District was entered in the National Register of Historic Sites on March 18, 1975. The Poppasquash Farms Historic District was completed in April, 1980, and forwarded to the Secretary of the Interior for final approval.

Historically, the development of maritime commerce formed the economic basis for Bristol's extraordinary growth in the early nineteenth century. Recreational boating is today the major use of this harbor. We urge that any design consider the safety of small boats, commercial fishing boats, and ferries, and not inhibit easy access to the dock space on either the east or west shore of the harbor. At present there would appear to be no impact or effect on archeological resources.

This Commission would be happy to review plans as they are finalized for an offshore breakwater, designed to reduce wave action and to protect the waterfront. If you have further questions about cultural resources, please contact us.

Very truly yours,

Elizabeth S. Warren

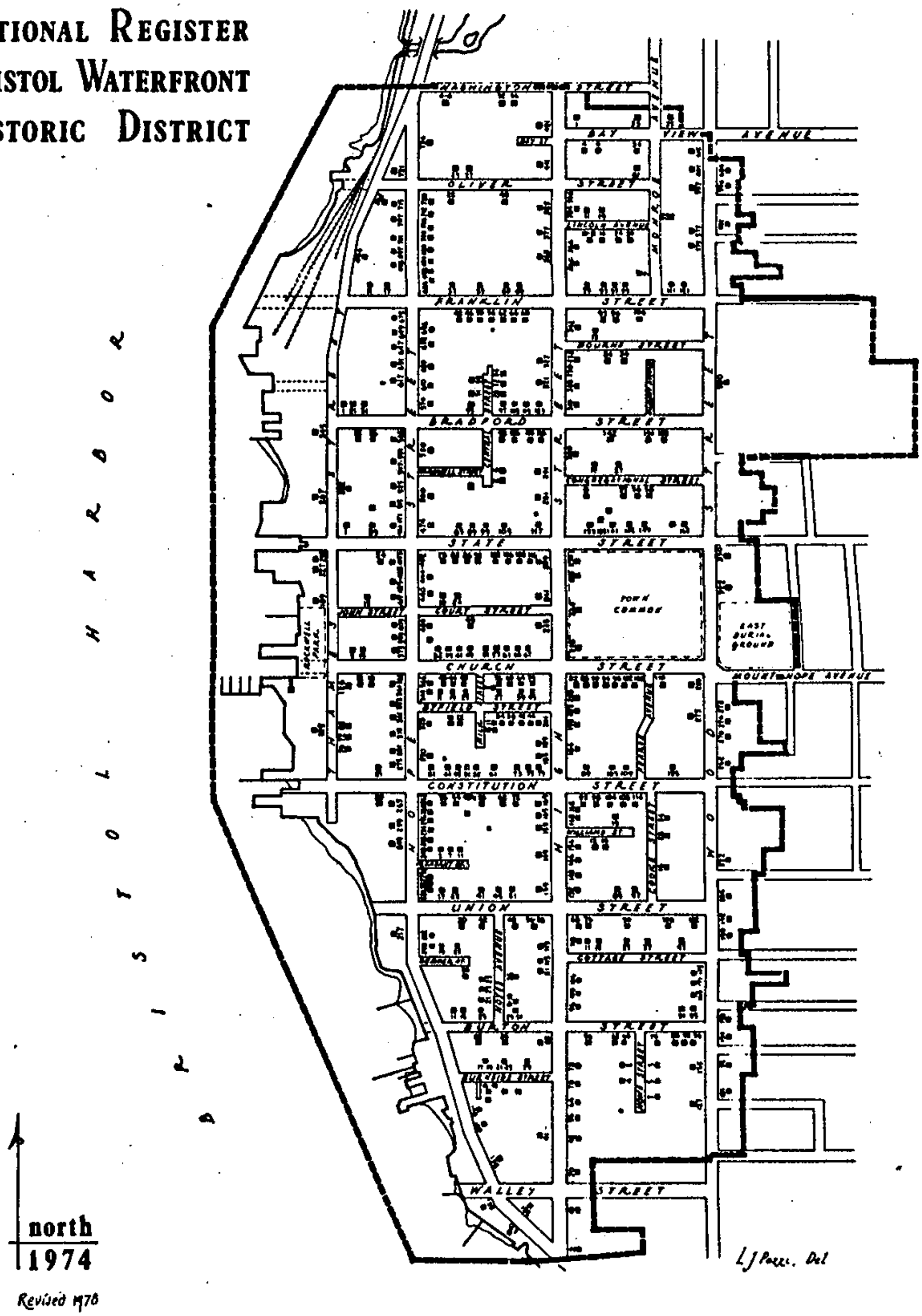
Elizabeth S. Warren
Principal Historic Preservation Planner

/mm

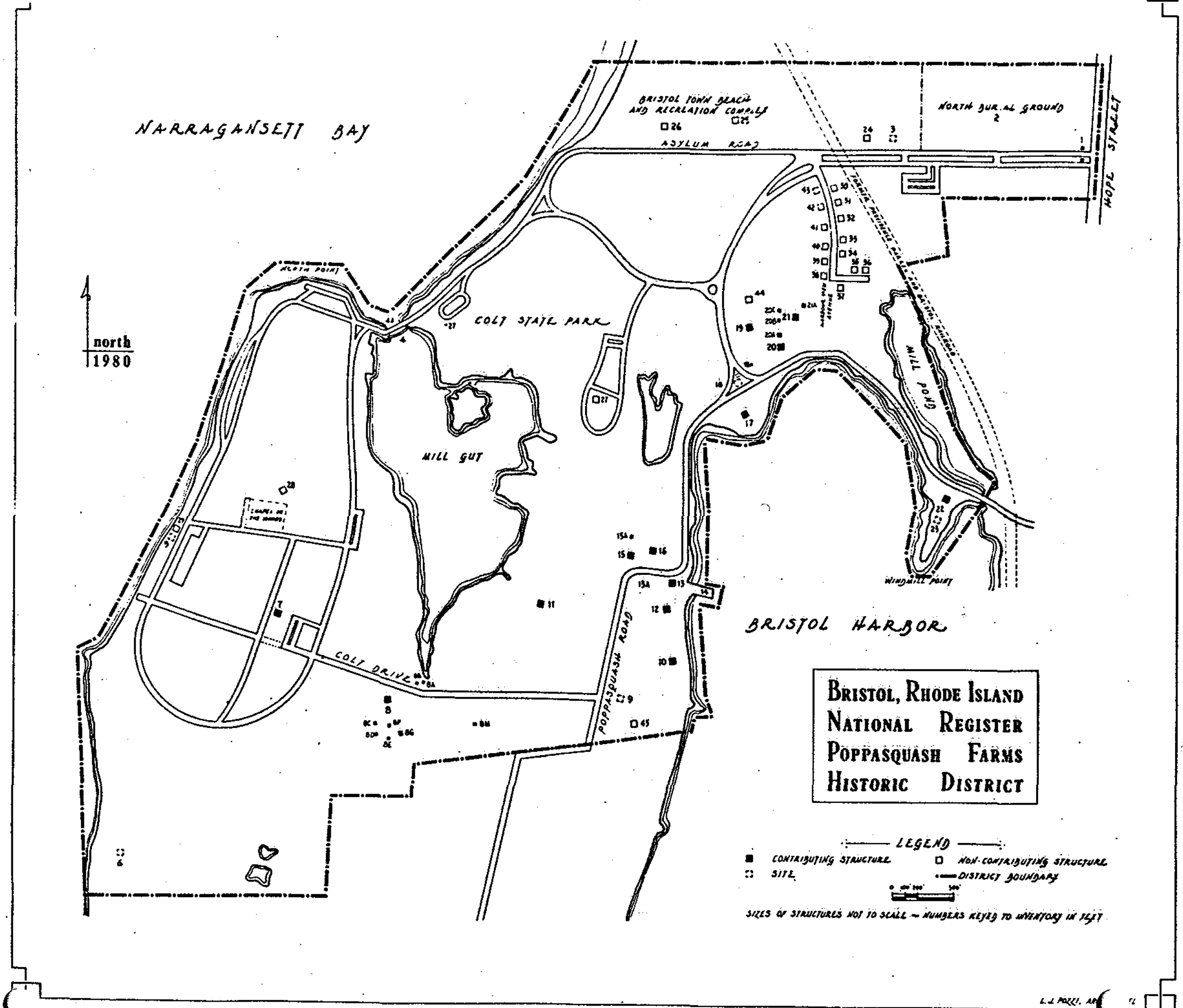
Enclosures

cc: Eric Hertfelder

National Register Bristol Waterfront Historic District



C-16


NARRAGANSETT BAY
BRISTOL TOWN BEACH AND RECREATION COMPLEX
ASYLUM ROAD
NORTH BURIAL GROUND
HOPE STREET
NORTH POINT
COLT STATE PARK
MILL GUT
MILL POND
WINDMILL POINT
BRISTOL HARBOR
COLT DRIVE
POPPASQUASH ROAD
north
1980
BRISTOL, RHODE ISLAND
NATIONAL REGISTER
POPPASQUASH FARMS
HISTORIC DISTRICT
LEGEND
CONTRIBUTING STRUCTURE
NON-CONTRIBUTING STRUCTURE
SITE
DISTRICT BOUNDARY
SIZES OF STRUCTURES NOT TO SCALE — NUMBERS KEYED TO INVENTORY IN TEXT

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
ECOLOGICAL SERVICES
P.O. Box 1518
Concord, New Hampshire 03301

JUL 11 1980

Colonel William E. Hodgson
Deputy Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Hodgson:

This letter supplements our report of July 11, 1979, concerning your study of navigation improvements for Bristol Harbor, Rhode Island. Mr. Ignazio's letter of January 4, 1980, advised us that three plans for breakwater construction are now being considered.

We discussed the impacts of Plan A (a 1,600-foot breakwater at the center of the entrance) in our previous report. Occupation of benthic habitat also will occur if any breakwaters are constructed at other sites. This loss of habitat will be the most important adverse impact if the project is constructed. Some of the loss would be mitigated by benthic production of organisms attached to and attracted to the stone breakwater. However, quahogs are not expected to use the sloping, stony surface of the breakwater; therefore, this loss cannot be mitigated during the 50-year project life. Moving quahogs away from the work area would be desirable. The difference between the area that would be occupied, 4.0 acres, 3.6 acres, and 5.0 acres respectively for Plans A, B, and C, is not significant enough to become a criteria in choosing the best plan.

We see no distinct advantage for fish and wildlife habitat development which would encourage us to prefer one plan or the other. However, construction of a 1,700-foot breakwater connected to the east shore under Plan B or C will offer an opportunity for public use that is not possible with Plan A.

Public access for fishermen and others should be provided. A parking lot and a safe surface for walking along the top of the breakwater would be necessary to facilitate public use. With these facilities the breakwater would be used by many fishermen, hunters, and other recreational users. The private land that would abut the west breakwater would probably not be available for public access.

We conclude that Plan B seems to offer the most advantage because it would make public use possible while not disturbing a large area of benthic habitat. The tidal circulation in the harbor is critical to the resources and a prediction of the impacts of the breakwater on this circulation will be important in the final choice. We would appreciate a chance to review the results.

Sincerely yours,

Gordon E. Beckett

Gordon E. Beckett
Supervisor

STATE OF RHODE ISLAND & PROVIDENCE PLANTATIONS
EXECUTIVE CHAMBER
PROVIDENCE

J. JOSEPH GARRAHY
GOVERNOR

July 22, 1980

Colonel Max B. Scheider
Division Engineer
Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Colonel Scheider:

In response to your letter of June 23 to Governor Garrahy regarding cost sharing for the proposed Bristol Harbor breakwater, the State of Rhode Island has no formal policy on cost sharing with affected cities and towns for local navigation projects. To the best of my knowledge, after considerable research, however, it has never done so.

Sincerely,

Malcolm J. Grant

Malcolm J. Grant
Policy Associate for
Environmental Affairs

MJG:jmd

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:
NEDPL-C

28 July 1980

ANNOUNCEMENT

OF

PUBLIC MEETING

FOR

PHASE 1 ADVANCED ENGINEERING AND DESIGN STUDY

OF THE

AUTHORIZED BRISTOL HARBOR BREAKWATER

IN

BRISTOL HARBOR, RHODE ISLAND

To Be Held at Colt Elementary School Auditorium
Corner Bradford and Hope Streets, Bristol, Rhode Island
at 7:30 P.M., 21 August 1980

The Division Engineer, New England Division, has been directed to make a post authorization and Phase I Advanced Engineering and Design Study of the Bristol Harbor Breakwater, which was authorized by Public Law 90-483, 90th Congress S3710, August 13, 1968, Section 101 of the 1968 River and Harbor Act. Funds to initiate the study were received on 1 October 1978. An announcement of the start of the study efforts was mailed to the general public on 14 February 1979.

The authorized project provides for an offshore rock breakwater 1,600 feet long, with a top width of ten feet at elevation 10 feet above MLW, and side slopes of 1.5 on 1.0. It would begin about 400 feet west of the Coast Guard Pier, then extend generally in a northwesterly direction. It would not be connected to either shore.

The purpose of the Phase I AE&D Study is to bridge the gap between the time the project is authorized and the time when detailed engineering and design plans are started. Since the gap is often many years, during which time significant changes may occur in purpose or scope of the project and desires of local interests, a reevaluation and analysis of the authorized plan is undertaken to reflect current price levels, legislative authorities, administrative evaluation criteria, conditions of the project area, public views and attitudes, and other changes which may have occurred since completion of the original survey report.

Two additional rock breakwater alignments were investigated along with the authorized plan. The environmental impact, as well as other means of providing protection and increased recreational boating use, were also investigated. The breakwater plans are shown on Inclosure No. 1.

The approximate, current cost (April 1980) and cost-sharing percentages for each breakwater plan is as follows:

	PLAN A	PLAN B	PLAN C
Corps of Engineers	$2,824,000 (50%)	$3,965,000 (68%)	$4,905,000 (62%)
Local	2,824,000 (50%)	1,866,000 (32%)	3,006,000 (38%)
Sub-total	$5,648,000	$5,831,000	$7,911,000
U.S.C.G.	10,000	10,000	10,000
Total Cost	$5,658,000	$5,841,000	$7,921,000

The purpose of this public meeting is to present the details of the alternative plans and the environmental impacts to local interests and inform them of our findings as well as solicit their views, comments and future desires.

If local interests select a plan of protection and provide us with reasonable assurance that they will participate in the cost sharing of the project, the Phase I AE&D Study will be completed and the Phase I General Design Memorandum (GDM) Report and revised Environmental Impact Statement (EIS) will be prepared. The Report, including the EIS, will then be forwarded to the Office of the Chief of Engineers (OCE) and the Board of Engineers for Rivers and Harbors (BERH) for review and processing. The public then will be given 30 days in which to review the report and submit comments to the BERH, for consideration in its review. After this, the report will be transmitted to the Secretary of the Army for approval and permission to initiate Phase II Advanced Engineering and Design (AE&D) Studies which deal with the technical design of the structures and facilities necessary to complete the project.

The last step in the process involves the development of detailed plans and specifications prior to initiation of construction.

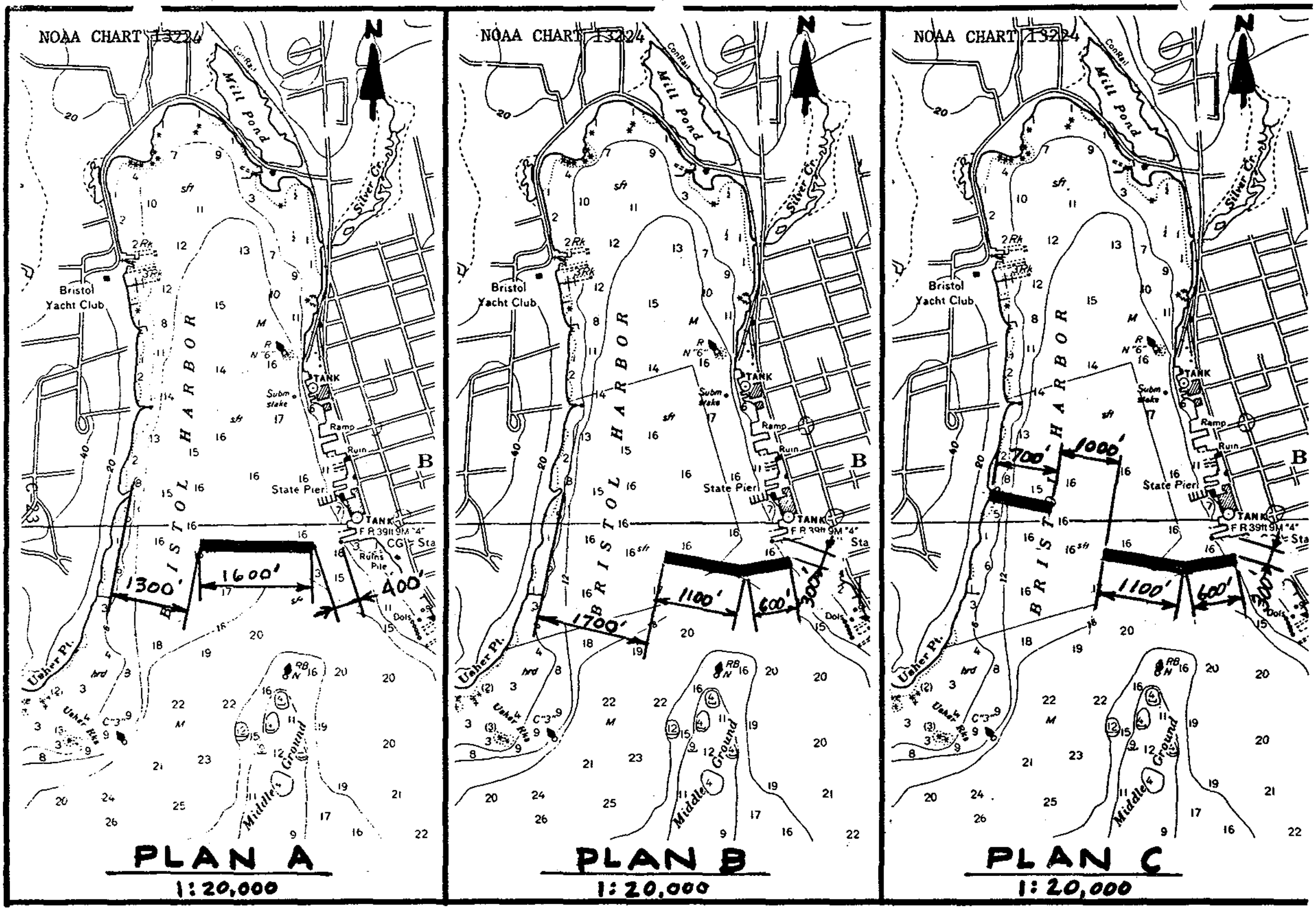
This announcement is being sent to you and other persons and agencies known to be interested in this matter, to solicit information and/or comments that might be useful in expediting the overall study effort. If you have any pertinent information you feel will be helpful, please present it at the meeting or submit it to the address below at least one week before the meeting.

Division Engineer
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Mass. 02154

Please bring this announcement to the attention of anyone known to you to be interested in this matter.

1 Incl
as stated

MAX B. SCHEIDER
Colonel, Corps of Engineers
Division Engineer



BRISTOL HARBOR RHODE ISLAND
ALTERNATIVE ROCK BREAKWATER PLANS
CORPS OF ENGINEERS, NED
August 1980

INCLOSURE No. 1

Bristol County Chamber of Commerce

654 Metacom Avenue
Warren
Rhode Island 02885

Anne B. Bates
Executive Director
401-245-0750

MOTION: The Board of Directors of the Bristol County Chamber of Commerce has reviewed the proposals dated July 28, 1980 of the U.S. Army Corps of Engineers for breakwater protection in Bristol Harbor, and hereby recommends Plan B. We support this plan because it offers the best possible protection to the half mile of commercial property on the Bristol waterfront between Constitution Street and Oliver Street. This protection is the keystone in developing the Bristol waterfront for a wide range of marine uses. We view the project as an investment in the future economy of the Town of Bristol and the Narragansett Bay area. We feel the cost is justifiable in light of the economic benefits this protection will bring to the tax base of the Town of Bristol; to the jobs it will produce; and to the present economic blight on the Bristol waterfront which it will eliminate. We urge the Town Council of Bristol to take positive steps toward its approval.

Board of Directors
Bristol County Chamber of Commerce

Serving Barrington, Warren and Bristol

TO: Town Council, Bristol, R.I.; and the Department of the Army, Corps of Engineers, New England Division

MOTION: The Executive Committee of the Bristol Yacht Club recommends construction of a breakwater in Bristol Harbor, specifically Plan B as outlined in the U.S. Army Corps of Engineers report dated 28 July 1980. The proposed breakwater will create some interference with the sailing qualities of Bristol Harbor but will provide a much needed refuge for pleasure and commercial craft during storm conditions. This project appears to be a worthwhile long range investment in the economy of the town of Bristol.

STATEMENT TO ARMY CORPS OF ENGINEERS
AND THE TOWN COUNCIL OF BRISTOL

Gentlemen:

I am Fred Pacheco, owner of Bristol County Travel Agency, 555 Metacom Ave., Bristol. In my travels to various locations I have seen breakwaters protecting harbors in dozens of places. In each case there is a correlation between the breakwater structure and the economy of the port it protects. In other words, breakwater equals economic prosperity for the area it protects.

Two of the best examples of this are the breakwaters which protect the harbors at Ponta Delgada and Horta, in the Azores. These ports, which are very important to the economy of the Azores, would be useless without good protection.

This is the case in Bristol. We have a natural, deep-water harbor, but its value to the economy of the Town of Bristol is neutralized by the serious exposure problem to the south. Various efforts have been made by the town and private property owners to develop the waterfront, but I think we can all agree that these efforts have been wasted away by the lack of protection.

I look at this proposal, in particular Plan B, as a great step toward the realization of the full potentials Bristol Harbor holds for the Town of Bristol. As various industries have departed from Bristol during the past 25 years -- I refer to the textile industry, the wire and cable industry and the shoe industry -- the one industry which has come forth to provide jobs is the marine industry. This is where Bristol's 300-year heritage lies, and it is up to us to see that we do what we can to improve and protect this part of our economy.

I strongly urge the Town Council to cooperate in this project by giving the people of Bristol the privilege of voting on it.

COMONAL M. 3 SCHEIDER

AS ONE WHO HAS LIVED ON THE WATER FRONT IN BRISTOL ALL OF MY LIFE, I HAVE BEEN APPROACHED MANY, MANY TIMES BY PEOPLE WHO HAVE COME INTO OUR HARBOR LOOKING FOR A SAFE PLACE TO MOOR THEIR BOATS, BUT HAD TO LEAVE BECAUSE OUR HARBOR WAS UNPROTECTED FROM THE ELEMENTS

IF WE HAD A SAFE HARBOR MANY OF THE FISHING BOATS LOBSTER BOATS DEEP SEA SCALLOP BOATS AND MANY OTHER THAT ARE NOW BEING CROWDED OUT OF NEW PORT WOULD COME HERE.

A WHOLE NEW INDUSTARY WOULD SPRING UP, THE TOUREST TRADE WOULD CROWD OUR TOWN AND WATER-FRONT BRINGING MUCH NEEDED DOLLARS TO OUR COMMUNITY

REMEMBER IF YOU WILL, THAT BRISTOL WAS ONCE A FAMOUS SEA-PORT.

IT COULD HAPPEN AGAIN IF BRISTOL HAD A BREAK-WATER.

THIS MAY BE THE LAST CHANCE TO BRING BACK THE GLORY TO THE SEA-PORT OF BRISTOL THAT IT WAS ONCE FAMOUS FOR.

THANK YOU

Jim O. Reilly

126 THAMES ST.

BRISTOL R.I.

Prudence Island Navigation Company

BRISTOL, RHODE ISLAND
FERRY SERVICE TO PRUDENCE AND HOG ISLAND
SPECIAL CHARTERS, MOONLIGHT SAILS

Address Reply:
Church Street Dock

August 13, 1980

Division Engineer
U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham, MA 02154

Reference: Announcement of Public Meeting for Phase 1 Advanced Engineering and Design Study of the Authorized Bristol Harbor Breakwater

Gentlemen:

With regard to the above referenced notice, I hereby submit the following comments:

In view of the three proposed plans, we are impressed by Plan B because it does not reduce the sailing qualities of Bristol Harbor, and is the least costly to the Town, which will be called upon to finance one-half of the local cost.

We are also in favor of this Plan as it appears to answer the original plea for protection of the downtown waterfront on the east side of the harbor. Exposure to waves devalues the property and makes it very unsafe and less usuable for most waterfront use.

There is a strong need for the development of the waterfront, and the development of this assent, including the construction of the breakwater would be of an important economic benefit to the Town.

Very truly yours,

PRUDENCE ISLAND NAVIGATION CO., INC.

Luther H. Blount
President

LHB/gr

cc: Bristol Town Council

robin rug, inc.
125 THAMES STREET, BRISTOL, RHODE ISLAND 02809
TELEPHONE: (RHODE ISLAND AREA CODE 401) 253-8350

August 15, 1980

Division Engineer
U.S. Army Engineer Division, New England
424 Trapelo Road
Waltham, Mass. 02154

Gentlemen: Re: NEDPL-C

In answer to the announcement received form the Corps of Engineers for a proposed breakwater.

We are very much in favor of having a breakwater in Bristol Harbor such as Plan B.

Having property located on the waterfront, which we are in the process of spending a considerable amount of money to repair the erosion and other damages caused by not having a breakwater.

We would be strongly in support of the breakwater project to insure our harbor line for safety and protection,also to be able to use our waterfront productively.

Thank you.

Very truly yours,

ROBIN RUG, INC.

Gordon Karian

GK:cd
copy:Bristol Town Council

PREMIER
ESTABLISHED 1921
PREMIER THREAD CO., INC.
345 THAMES STREET · BRISTOL, R.I. 02809
401 253-9000

August 19, 1980

Division Engineer
U. S. Army Engineer Division,
New England
424 Trapelo Road
Waltham, Mass. 02154

Dear Sir:

The Premier Thread Company owns 735 feet of waterfront property on Bristol Harbor in the area which would receive protection from the proposed breakwater structure. Because of exposure to seas from the south, this property is useless for marine activity, both commercial and pleasure.

As owners of private property we recognize that construction of a breakwater will allow development of this wasted asset. In turn, this will aid the economy of the town and the entire Narragansett Bay area. Because of the depth of the harbor bordering the docks on the east side of the harbor, its geographical location on the bay, and the presence of related facilities and utilities, this location has outstanding economic potential.

We support Plan B as outlined in your report dated July 28, 1980, and urge that the Town Council of the Town of Bristol take positive steps to support the plan.

Very truly yours,

PREMIER THREAD COMPANY

W. Richard Mahoney
Vice-President

WRM:fac

MANUFACTURER OF SYNTHETIC SEWING THREADS

SHANNON BOAT COMPANY, INC.

August 20, 1980

Division Engineer
U.S. Army Engineer Divison, New England
424 Trapelo Road
Waltham, MA 02154

Dear Sirs:

I am in receipt of the proposed plans for a breakwater to be constructed in Bristol Harbour. After reviewing the preliminary plans and concept, we are in complete agreement over the importance of having a breakwater constructed in Bristol.

Since the name Bristol has always been nationally identified with marine activities, it is unfortunate that the lack of facilities and a protected harbour has retarded the expansion of the marine industry and general growth in the area. In addition, the historical aspects of the town have not been capitalized upon and tourism has suffered because of the poor harbour. It is obvious that Newport has shown great vitalization in the past decade because of the marina and anchorage availability. Towns such as Stonington, CT; Port Jefferson, NY; Stamford, CT; and Provincetown, MA have all substantially benefited from man-made breakwaters created to protect a previously exposed and under-utilized harbour.

In my opinion, a protected harbour will not only bring people to the town by boat, but will also bring dollars into the community from people coming to look at boats, sightseers, marinas, and those attracted to the area because of the atmosphere. There is tremendous potential just from the spill over from Newport's tourist and investment growth. This activity will promote investment and development in the town which would increase the tax base, create jobs, and revitalize the town in general.

During the same decade that Newport went from a second rate Navy town into a major tourist and development center, Bristol has suffered a decline in the industrial sector without any major effort to offset the loss. The town has a fantastic natural resource in the harbour and land around it, but money, time, and creativity will have to be expended to create growth in the community without jeopardizing the environment or disturbing the present taxpayers.

While I am in support of "PLAN B", I feel that a breakwater should be part of an overall master plan to revitalize and broaden the potential tax base in Bristol. If anything, "PLAN B" is the minimum effort needed at this time, because it does not provide

BOX 388, 19 BROAD COMMON ROAD, BRISTOL, RI 02809 • 401-253-2441

full protection for a valuable portion of the harbour and real estate to the northeast. However, any movement to create positive growth in the area should be vigorously supported and implemented.

It may seem that anyone involved in boating would obviously support any activity at any cost that would expand water recreation programs. However, Shannon Boat Company, because of the scope of our operations, will probably receive little direct benefit from the breakwater, but the indirect value from Bristol's growth and future will be beneficial to everyone in the community. Our support of the plan is related to the potential created for the town of Bristol, rather than personal or corporate gains from docking or mooring boats behind a breakwater.

Very truly yours,

Walter A. Schulz
President

WAS/jas

HALL SPARS

August 21, 1980

Max B. Scheider
Colonel, Corps of Engineers
Division Engineer
U. S. Army Engineer Division, N.E.
424 Trapelo Road
Waltham, MA 02154

Dear Sir:

We are aware of the Corps of Engineers proposals for construction of a breakwater in Bristol Harbor.

We endorse the idea of a breakwater in Bristol Harbor. We feel that not only will it provide storm protection but will also open up the waterfront area for realistic development. It will allow local marine industries to operate more effectively (for instance, it would provide Hall Spars, Inc. a calm water area to step and rig sailboat masts.)

As the local marine industry operates more effectively, more business will gravitate toward Bristol which is already the geographical center of boating activity on Narragansett Bay. With new business will come new jobs helping offset losses in industrial jobs in the last ten years.

Obviously local business revitalization will increase the town tax base.

We have studied all three proposals in detail and favor Plan B which gives maximum waterfront protection yet still allows enough room for recreational boating especially club and junior sailboat racing.

We look forward to the initiation of construction of a breakwater in Bristol Harbor under Proposal B.

Yours truly,

HALL SPARS, INC.

Eric R. D. Hall
President

ERDH/car

HALL SPARS, INC. • 7 BURNSIDE STREET • BRISTOL, R.I. 02809 • 401-253-4858

most fully protect the harbor, serve the greatest number of people and facilities and provide the highest ratio of benefits for the dollars spent.

Thank you for your consideration.

Very truly yours,

Clinton J. Pearson Pres.

Clinton J. Pearson

CJP/mjs

Tel. 253-5200
Ext. 46

Bristol Marine Company

Poppasquash Road P. O. Box 508
Bristol, R. I.

Zip Code 02809

August 21, 1980

Max B. Scheider
Colonel - Corp of Engineers
Division Engineer
U. S. Army Engineer Division, N. E.
424 Trapelo Road
Waltham, Ma. 02154

Dear Mr. Scheider:

This company has operated a boat yard on the easterly side of Poppasquash Point near the head of Bristol Harbor for 20 years. During this period of time southerly and southeasterly storms, which occur regularly, have been devastating. It is a rare year when wave action from these storms does not cause several fishing craft and other small boats to be torn from their moorings or slips and smashed against the sea wall at the north end of the harbor. Our shore facilities have also been substantially damaged in these storms. In addition to the destruction of property caused by this wave action, there is always the grave risk of serious personal injury or death to any person caught on a boat or attempting to rescue a boat during storm conditions. Even when a storm causes no physical damage, our company loses many man hours making preparations to protect boats and other property whenever a storm is predicted for the area. In some years the cost of these preparations exceeds the actual physical damage sustained. I feel very strongly that the public awareness of the storm caused damage in Bristol Harbor severly limits our growth and the development of other water front facilities in Bristol Harbor to serve commercial, fishing and recreational boating interests.

Because of these concerns, I have carefully reviewed the various proposals set forth in your 28th July, 1980 announcement of public meeting regarding the proposed Bristol Harbor breakwater. Based on this study, I heartily endorse Plan B as the proposal which will

TOWN OF BRISTOL

RHODE ISLAND

TOWN HALL 10 COURT STREET

TOWN COUNCIL

MICHAEL H. CAMPBELL, CHAIRMAN
THOMAS J. DaPONTE, VICE CHAIRMAN
EDWARD H. HOLMES, COUNCILMAN
VALENTINE VERNA, COUNCILMAN
RALPH D. ABERCROMBIE, COUNCILMAN

ORLANDO J. BISBANO
COUNCIL CLERK

September 12, 1980

Mr. Max B. Scheider
Colonel, Corps of Engineers
Division Engineer
U.S. Army Engineer Division, N.E.
424 Trapelo Road
Waltham, Massachusetts 02154

RE: Breakwater - Bristol Harbor

Dear Sir:

Please be informed that Bristol's Town Council, at its meeting September 10, 1980 voted unanimously to pass the following resolution:

> Whereas a breakwater is necessary to safeguard Bristol Harbor and its commerical fishing boats and fishing facilities and otherwise protect Bristol's waterfront economic base, and whereas Plan B is the optimum, most cost-effective implementation of a breakwater, the Town Council hereby resolves to endorse Plan B and to inform the U.S. Corps of Engineers of the Town's intent to participate actively in the sharing of the costs of the project, to investigate actively the various sources of financing, subject to clarification from the Corps regarding the nature of financial commitment that is required and the time constraints. Furthermore, the Town Administrator is authorized to investigate alternative means of financing, to seek clarification from the Corps of Engineers, and to act in the best interest of the Town in accomplishing this worthy project.

Sincerely yours,

Orlando J. Bisbano

Orlando J. Bisbano, CMC
Council Clerk

r

ATLANTIC OFFSHORE FISH & LOBSTER ASSOC.

P.O. BOX 438
BRISTOL, RHODE ISLAND 02809

30 January 1981

From: Atlantic Offshore Fish and Lobster Association
To: Army Corps of Engineers

Subj: Bristol Harbor

1. The Atlantic Offshore Fish and Lobster Association (AOFLA) represents all types of fishermen from North Carolina to Maine. We are the largest such multi-state organization with first-hand knowledge of the needs of the commercial fishermen.

2. One of the most pressing problems facing the commercial fishermen is that of adequate shore side facilities. Currently Rhode Island has only two major facilities -- Pt. Judith and Newport (the latter is slowly but surely changing to a recreational/tourist community). The status of commercial fishing in Rhode Island is thoroughly described in the attached report which was recently issued by the state.

3. Why Bristol for a commercial fishing port? Taking into consideration the needs of the commercial fishermen and the available locations in Rhode Island that could possibly accommodate such needs, Bristol offers the best potential because (a) fishermen want to be assured a berthing space for their vessel when they return after a long trip; (b) they want to be closer to their fishing grounds (some of the vessels that would relocate to Bristol if a breakwater and docking space were available would save anywhere from 8-20 hours of steaming time per trip in addition to a great savings in fuel expense -- an average of 10 hours of steaming time could save approximately $300-$400 per trip); (c) shore side support is very important to commercial fishermen. There are several possibilities of locating some type of processing facility adjacent to the dock which could be privately owned or a co-op arrangement giving the fishermen a more stable price for their product; (d) accessibility to the Boston market by truck; (e) availability of skilled labor in the Bristol area to support the fleet and a labor pool to draw from for other fleet related operations; (f) a more direct access to a large percentage of the consumer market, offering higher value to the consumer. In fact all of the above would in turn result in a savings to the consumer.

4. The above is a brief explanation of some of the economic benefits to be gained by commercial fishing vessels operating out of Bristol, Rhode Island. If this association can be of further assistance, please contact the undersigned at 203-535-3241.

Sincerely,

ALAN D. GUIMOND
Executive Director

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Services Division
Habitat Protection Branch
7 Pleasant Street
Gloucester, MA. 01930

March 17, 1981

Mr. Gib Chase
Environmental Assessment Section
Department of the Army
New England Division
Corps of Engineers
424 Trapelo Road
Waltham, MA. 02254

Dear Mr. Chase:

This is in response to your request for information regarding endangered or threatened species that may be found in the vicinity of Corea Harbor, Portsmouth-Piscataqua River, Searsport Harbor, Bristol Harbor, Lynn Harbor, Bridgeport Harbor and New London Harbor.

We have reviewed each project relative to the need for assessments of impacts under Section 7 of the Endangered Species Act of 1973, as amended.

The Bristol, (Rhode Island) and Searsport, (Maine), harbor projects involve the construction of breakwater in areas where no endangered or threatened species under the jurisdiction of the National Marine Fisheries Service are known to exist. Therefore, further Section 7 consultation on those projects will not be necessary.

The Corea, (Maine), Lynn, (Massachusetts), Bridgeport, (Connecticut), and New London, (Connecticut) harbor projects all involve dredging. The project plans are not clear on either the time of year the dredging will take place or the exact location chosen for dredge spoil disposal. However, all four projects are in a region inhabited by three endangered whale species; the finback whale (Balaenoptera physalus), the humpback whale (Megaptera novaeangliae), and the right whale (Balaena glacialis). In addition, the two Connecticut projects (Bridgeport and New London) are in a region inhabited by the threatened loggerhead sea turtle (Caretta caretta) and the endangered leatherback sea turtle (Dermochelys coriacea).

None of the four projects are believed to have any effect on the endangered whale or endangered and threatened sea turtle species, provided either one of the two situations stated below exists:

1. The disposal site for the dredge spoil is either onshore or in an inshore area where food/prey organisms of the listed endangered/threatened species are not found; and/or

2. The dredge spoil disposal will take place between December 1 and May 1, when these species are not known to inhabit the region.

The Portsmouth-Piscataqua River project is a dredging project that will occur in the same region seasonally inhabited by the fin, humpback and right whales as stated above for Corea and Lynn harbors. The proposed offshore dredge spoil disposal site is adjacent to Jeffrey's Ledge where the three whale species are known to congregate and feed from May 1 until October 31. This project is similar to a project previously reviewed under Corps of Engineers Public Notice #NEOD-26-78-266. During the review of this project, the presence of endangered shortnose sturgeon (Acipenser brevirostrum) was discussed. There was only one record of this species in the river in 1971. Furthermore, the project area to be dredged is in the lower saline section of the estuary where sturgeon are not frequently found. Therefore, we concur with the assessment made for the 1978 Public Notice that the project will not adversely affect shortnose sturgeon.

If dredge spoil disposal in any of the five dredging projects mentioned above are going to take place between May 1 and October 31 on offshore sites in areas where food/prey organisms of the species mentioned above are known to exist, then the Corps of Engineers should assess the following potential impacts of the spoil:

1.) direct effects on whales/turtles such as effects on skin and baleen of whales or ingestions by whales or turtles;

2.) indirect effects such as causing avoidance of an area by whales/turtles or affecting whales/turtles through the food chain; and

3.) direct effects on whale/turtle food species such as herring, sand lance, euphausiids, copepods or jellyfish. Effects to food species could be either direct reduction of food species abundance or density through mortality or dispersal of food species concentrations.

We should be kept appraised of any changes in the project plans as they may change the basis for the determination made herein. We look forward to reviewing the final plans for these dredging projects.

Sincerely,

Douglas W. Beach

Douglas W. Beach
Wildlife Biologist
Acting Branch Chief

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
COMMANDER (oan)
FIRST COAST GUARD DISTRICT
150 CAUSEWAY STREET
BOSTON, MA 02114
Tel: 617-223-3632

APR 2 1981
16530

From: Commander, First Coast Guard District
To : Division Engineer, New England Division, Army Corps of Engineers
Attention: NEDPL-C

Subj: Navigation Study, Bristol Harbor, Rhode Island

Ref : (a) Your ltr dtd 10 NOV 80

1. The three alternative plans for the proposed Bristol Harbor Breakwater received with reference (a) have been reviewed as requested and the following information applies.

Aids to Navigation Costs

	Initial	Annual Maintenance
Plan A	$6,000	$1,650
Plan B	6,500	1,650
Plan C	9,500	2,475

Plan A calls for the establishment of two unattended battery powered lights. Plan B establishes two unattended battery powered lights and disestablishes one existing commercially powered light. Plan C establishes three unattended battery powered lights and disestablishes one existing commercially powered light.

T. P. SCHAEFER
By direction

TOWN OF BRISTOL, RHODE ISLAND

Office of Town Administrator

TOWN HALL
10 COURT STREET
BRISTOL, RHODE ISLAND 02809

SARAH AMARAL
Town Administrator

Telephone (401) 253-7000

June 8, 1981

Mr. Joseph L. Ignazio
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

RE: Disposal Site for Bottom Silt

Dear Mr. Ignazio:

Received your communication in regards to a possible disposal site for approximately 40,000 cubic yards of bottom silt in our landfill.

I have spoken with the Director of Public Works, and he has informed me that this could be accommodated at the landfill, in view of the fact that the State has allowed us to use dredging material at a previous time.

I am giving tentative approval, but I must consult with the Council for final approval. They will meet on Wednesday, June 10, 1981 at which time I hope to give you final approval.

Sincerely yours,

Sarah Amaral

(Mrs.)Sarah Amaral
Town Administrator

SA/r

TOWN OF BRISTOL, RHODE ISLAND

Office of Town Administrator

TOWN HALL
10 COURT STREET
BRISTOL, RHODE ISLAND 02809

SARAH AMARAL
Town Administrator

Telephone (401) 253-7000

June 11, 1981

Mr. Joseph L. Ignazio
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

RE: Disposal Site for Bottom Silt

Dear Mr. Ignazio:

The Town Council, at its meeting of June 10, 1981, approved of disposing the bottom silt in our landfill.

Please contact us when you plan on doing such.

Sincerely yours,

Sarah Amaral

(Mrs.) Sarah Amaral
Town Administrator

SA/r

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

COASTAL RESOURCES MANAGEMENT COUNCIL
60 Davis Street
Providence, R.I. 02908

June 15, 1981

Mr. Joseph L. Ignazio, Chief
Planning Division
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02254

Dear Mr. Ignazio:

The Coastal Resources Management Council has underway an effort to prepare a special area plan for the Brenton Reef dredged material disposal site. This site is envisioned as the state's open water material disposal and management area, and it would be preferrable to the Prudence Island dump grounds for the disposal of the 40,000 cubic yards of disposable material estimated in Bristol Harbor.

Very truly yours,

John A. Lyons

John A. Lyons, Chairman
Coastal Resources Management Council

JAL/lmc

TOWN OF BRISTOL

RHODE ISLAND

TOWN HALL 10 COURT STREET

ORLANDO J. BISBANO
COUNCIL CLERK

June 17, 1981

Mr. Joseph L. Ignazio
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02254

Dear Mr. Ignazio: Re: Disposal Site for Bottom Silt

Reference is made to your communication dated June 1, 1981, requesting permission from the Town of Bristol to use its Sanitary Landfill area for disposal of bottom silt in the event ocean dumping is not permitted.

We are also in receipt of a copy of a communication from (Mrs.) Sarah Amaral - Town Administrator, giving tentative approval awaiting final approval from the Bristol Town Council.

At its regular meeting of June 10, 1981, the Council voted unanimously that a communication be sent to your attention approving the recommendation in regard to a possible disposal site for approximately 40,000 cubic yards of bottom silt at the Bristol Minturn Landfill site.

Very truly yours,

Orlando J. Bisbano

Orlando J. Bisbano, CMC
Council Clerk

:dac

cc: Town Administrator

ORLANDO J. BISBANO
COUNCIL CLERK

TOWN OF BRISTOL

RHODE ISLAND
TOWN HALL 10 COURT STREET

TOWN COUNCIL

EDWARD H. HOLMES, CHAIRMAN
LOUIS A. ANNARUMMO, JR., COUNCILMAN
PAUL A. D'AMICO, COUNCILMAN
LAWRENCE J. FERGUSON, COUNCILMAN
THOMAS J. DaPONTE, COUNCILMAN

June 19, 1981

Col. C. E. Edgar III
Corps of Engineers
Division Engineer
U.S.Army Engineer Division N.E.
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Bristol Harbor Breakwater

Dear Sir:

The Bristol Town Council, at its regular meeting of June 10, 1981, voted to reconfirm its resolution of September 10, 1980, supporting the construction of a breakwater in Bristol Harbor.

The approved Bristol Budget for 1981-82 contains an appropriation of $30,000. to fund the preparation of a master plan for the waterfront and downtown district with the single purpose of reviving commercial activity in this area. The selection of a consultant to develop the plan is forthcoming and work will begin shortly thereafter.

Additionally, the Town will work with the State of Rhode Island in obtaining the use of the present "Town Dock" and "Community Center" property for conversion to commercial fishing wharfage. The Town will also develop the State Street Dock as a support area where vessels will be able to obtain fuel, ice, and other necessary services. Private owners of commercially zoned waterfront property will be encouraged, in cooperation with the Town, to rehabilitate existing docks to provide additional berths.

The Town of Bristol looks forward to the construction of the Bristol Harbor Breakwater, the home-porting of twelve or more large harvesting vessels and the resurgence of Bristol as a major fishing port.

To accomplish this goal, the Town Council will continue to participate and support all aspects of the project.

Very truly yours,
Orlando J. Bisbano
Orlando J. Bisbano, CMC
Council Clerk

:dac

(203) 535-3241
(203) 535-3246

Stonington Seafood Products, Inc.
WHOLESALE DISTRIBUTOR
Specializing In Deep Sea Lobster
STONINGTON HARBOR
4 North West St. Stonington, Ct. 06378

October 29, 1981

Col. C. E. Edgar III
Corps of Engineers
Division Engineer
U.S. Army Division N.E.
424 Trapello Road
Waltham, MA 02154

Dear Sir:

The Corps of Engineers is hereby given permission to reproduce the Stonington Seafood Products, Inc. report dated June 1, 1981 in their Phase I A, E, and D General Design Memorandum for Navigational Improvements in Bristol Harbor, Bristol, Rhode Island.

Very truly yours,

STONINGTON SEAFOOD PRODUCTS, INC.

Alan Guimond
Alan Guimond
President

AG/ams

TOWN OF BRISTOL, RHODE ISLAND

Office of Town Administrator

TOWN HALL
10 COURT STREET
BRISTOL, RHODE ISLAND 02809

SARAH AMARAL
Town Administrator

Telephone (401) 253-7000

November 5, 1981

Col. C.E. Edgar III
U.S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

RE: Bristol Harbor Breakwater - Bristol, Rhode Island

Dear Col. Edgar:

This letter is to inform you of our progress since June 19, 1981 in developing Bristol Harbor as a commerical fishing port.

The Town of Bristol has retained the well known and respected firm of Sasaki Associates of Watertown, Massachusetts to prepare a master plan for development of a waterfront and downtown district for commerical purposes. This plan is scheduled for completion in March, 1982. Of the many development options available, the primary development consideration for portions of the waterfront will be directed toward commerical fishing interests. Basically, the plan, in this respect, will develop the required wharfage and shore based support facilities necessary to maintain an operation such as that detailed in the Stonington Seafood Products Report of June 1, 1981.

Based on the Congressional Authorization of 1968, the town has systematically established a landbank in the waterfront area and presently controls, thru ownership and lease, seven waterfront parcels with a total of two thousand seventy five linear feet of water frontage. Portions of this land are available to support the plan detailed above. The U.S. Coast Guard facility is also based on public land.

Our Planning Department, in conjunction with Sasaki Associates, is in the process of designating certain Town controlled parcels for commerical fishing interests. These parcels of land are: the Community Center and adjacent docks, the Rockwell Docks, Independence Park, and the State Street Dock.

Additionally, the Chamber of Commerce, Town Council, Economic Development Commission, Planning Board and Zoning Board are united in their effort to develop a totally new "Waterfront Zone" that will encourage commerical development only.

In conversation with Steven Onysko, Project Manager for the Bristol Harbor Project, it has been explained many times that the Town of Bristol is anxious to have this project implemented. The Town is doing, and will do everything within its ability to help make the Bristol Harbor Breakwater a reality and return Bristol to its former status as a major fishing port.

Thank you for this opportunity to write and explain the Town's plans and position.

Sincerely yours,

Sarah Amaral

(Mrs.) Sarah Amaral
Town Administrator

cc: Mr. Steven Onysko, U.S. Army Corps of Engineers

r

BRISTOL HARBOR
BRISTOL, RHODE ISLAND

PHASE I AE&D

APPENDIX D

ENGINEERING INVESTIGATIONS, DESIGN AND COST ESTIMATES

PREPARED BY THE
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

APPENDIX D

ENGINEERING INVESTIGATIONS, DESIGN AND COST ESTIMATES

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LIST OF PLATES

APPENDIX D

ENGINEERING INVESTIGATION, DESIGN AND COST ESTIMATES

SECTION A

DESIGN CRITERIA

INTRODUCTION

The principal problem in Bristol Harbor is inadequate protection of the existing and prospective recreational and commercial boating fleets, as well as shoreline structures, from storm waves originating in Narragansett Bay.

Design criteria was established to determine the optimum siting, wave heights, design of rock sizes, wave refraction and diffraction, and tidal current patterns for the alternative rock breakwaters in Bristol Harbor, as well as other pertinent data, described below.

TIDES

The tides in Bristol Harbor are semi-diurnal. Mean and Spring tide ranges are 4.0 and 5.0 feet respectively.

TIDAL CURRENTS

Tidal currents in Bristol Harbor, as given by the National Ocean Survey "Tidal Current Tables for 1981, Atlantic Coast of North America," are too weak and variable to be predicted.

PREVAILING WINDS

The maximum gust of wind recorded in New England is 186 mph and the maximum sustained 5-minute velocity is 121 mph, which were recorded in the September 1938 hurricane at the Blue Hills Observatory in Milton, Massachusetts, about 35 miles northeast of Bristol. The summer seasonal prevaling winds affecting Bristol harbor are from the southeast and southwest quadrant and can obtain speeds up to a gale force of 50 mph.

DESIGN TIDE

The design tide is the highest tide which is estimated to occur in the project area on the average of once per year. The tide in Bristol Harbor can be expected to reach one foot over a mean spring tide and the height of 6.0 feet (5.0 MST +1.0′ surge) was selected as the design still water level.

DESIGN WAVE

The height of the design wave is the significant wave (highest one-third of the waves and period in a wave train) which could be expected to reach the proposed structure at the time of a design tide. The wave was determined from the effective fetch of 3-3/4 miles from the SSW direction and 2.85 miles from the SSE direction, based on the irregular shoreline method and an average water depth of 25 feet, and is 4.0 feet, at design stillwater level. The significant wave period is 3.5 seconds, for a 50 mph wind speed and a 12 hour duration.

BREAKWATER DESIGN

Based on experience for rubble mound rock breakwaters placed in similar environments, minimum side slopes of 1.0 vertical on 1.5 horizontal were selected as being the most effective and economical, for both sides of the breakwater.

It has been assumed that stone will be obtained from a commercial quarry in Tiverton, Rhode Island. The quarry is located approximately 6 nautical miles southeast of the project site and has access to loading facilities located on the Sakonnet River. Stone frome this source is granite weighing 165 pounds per cubic foot. The breakwater design is based on the use of rough armor stone, individually placed, in two layers. The average weights of armor stone have been determined from the U.S. Army Coastal Engineering Research Center (CERC) guide equation shown in the "Shore Protection Manual" and is as follows:

$$W = \frac{WrH^3}{Kd(Sr-1)^3 \text{ Cot } \theta}$$

Where:

- W = Weight of armor stone in pounds
- Wr = Unit weight of armor stone in lbs/ft^3
- H = Design wave height at the structure in feet
- Sr = Specific gravity of armor stone relative to the water at the structure (Sr=Wr/Ww)
- Ww = Unit weight of sea water = 64.0 lbs/ft^3
- 0 = Angle of structure slope measured from horizontal in degrees
- Kd = Stability coefficient that varies primarily with the shape of the armor stone, roughness, and degree of interlocking obtained in placement.

The typical cross section of the breakwater and maximum and minimum weights of the armor and underlayer stone are shown on Plate D-1.

CREST ELEVATION AND WIDTH

An analysis of run-up and overtopping on permeable rubble slopes, in accordance with the Shore Protection Manual procedures indicates that there would be no overtopping of the 4-foot design wave with the crest elevation at 10.0 feet above MLW. The crest width was determined by the size and number of armor stones that would be used and was determined to be 10 feet wide.

REFRACTION AND DIFFRACTION

Refraction and diffraction analysis for Plans A, Plan B and Plan C were prepared and the results are shown on Plate D-2, Plate D-3 and Plate D-4, respectively. The area protected behind the breakwaters within a 1-1/2 foot wave height are approximately 70 acres, 65 acres and 150 acres, respectively.

SUBSURFACE INVESTIGATIONS

Thirty-three probings were made along the selected Plan C breakwater alignment in February 1981. The results of the probings indicate that the foundation materials consist of 5′ to 8′ of soft organic silts overlaying firm grandular soils. The soft material will either be dredged and disposed of at sea or on land, or displaced with a sand blanket. The location of the probings and results of each are shown on Plate D-5.

ALTERNATIVE DISPOSAL SITES

Numerous disposal sites throughout Narragansett Bay were considered for the dredged materials from Bristol Harbor. Plate D-6 shows the locations of the potential disposal sites. In addition the Brenton Reef - Newport Historic Dump Grounds and the Town of Bristol Sanitary Land Fill area were also considered.

Each of the potential disposal sites would have some environmental impact, whether in the ocean, on land, or in diked disposal areas near the waterfront or marsh creation, but would be mitigated to some extent over the long run.

At present, there is no State approved open-water disposal site in Rhode Island waters. However, the Department of Environmental Management and the Coastal Resources Management Council are preparing legislation that will open the Brenton Reef Dump Grounds in about a year.

The considered alternative disposal sites are discussed in the Environmental Assessment in the main report.

SECTION B

COST ESTIMATES

FIRST COSTS

Quantity estimates for dredging are based on hydrographic surveys done in December 1979. Material quantities are based on inplace measurement for dredging and design dimensions of the breakwaters. Any required sand or gravel fill materials would be obtained from local commercial sources within a 25 mile radius of the job site. Rock materials would be obtained from the rock quarry in Tiverton and barged to the job site, a distance of about 6 miles by water. Costs are based on July 1981 price levels.

Costs for engineering/design and supervision/administration are based on experience, knowledge and evaluation of the project site, and comparison with similar projects in the overall area. A summary of costs for each of the detailed plans is shown in Table D-1.

TABLE D-1
SUMMARY OF COST ESTIMATES

PLAN A (Authorized Alignment)	
Excavation, including disposal 40,000 c.y. @ $8/c.y.	$ 320,000
Coverstone, Type A, furnished and placed 24,960 tons @ $25.30/ton	631,500
Coverstone, Type B, furnished and placed 13,760 tons @ $25.30/ton	348,100
Bedding Stone, furnished and placed 17,760 tons @ 24.30/ton	431,600
Core stone, furnished and placed 145,440 tons @ $18.25/ton	2,654,300
Subtotal	$4,385,500
Contingencies, 15%	657,500
Total Construction Cost	$5,043,000
Engineering & Design, 5%	252,000
Supervision & Administration, 7%	353,000
Total First Cost	$5,648,000
U.S. Coast Guard, Aids to Navigation	6,000
Total Project Cost	$5,654,000
PLAN B (Selected Alignment)	
Excavation, including disposal 42,000 c.y. $ $8/c.y.	$ 336,000
Coverstone, Type A, furnished and placed 26,100 tons @ $25.30/ton	660,300
Coverstone, Type B, furnished and placed 14,320 tons @ $25.30/ton	362,300
Bedding stone, furnished and placed 18,510 tons @ $24.30/ton	449,800
Core stone, furnished and placed 148,970 tons @ $18.25/ton	2,718,700
Subtotal	$4,527,000
Contingencies, 15%	679,000
Total Construction Cost	$5,206,000
Engineering & Design, 5%	260,000
Supervision & Administration, 7%	365,000
Total First Cost	$5,831,000
U.S. Coast Guard, Aids to Navigation	6,500
Total Project Cost	$5,837,500

PLAN C (Alternative Alignment)

Excavation, including disposal 59,260 c.y. @ $8/c.y.	$ 474,100
Coverstone, Type A, furnished and placed 36,235 tons @ $25.30/ton	916,700
Coverstone, Type B, furnished and placed 19,834 tons @ $25.30/ton	501,800
Bedding Stone, furnished and placed 25,686 tons @ $24.30/ton	624,200
Core stone, furnished and placed 198,602 tons @ $18.25/ton	3,624,500
Subtotal	$6,141,300
Contingencies, 15%	921,200
Total Construction Cost	$7,063,000
Engineering & Design, 5%	353,000
Supervision & Administration, 7%	495,000
Total First Cost	$7,911,000
U.S. Coast Guard, Aids to Navigation	9,500
Total Project Cost	$7,920,500

PROJECT MAINTENANCE COSTS

The breakwaters would require periodic maintenance after construction is completed, as it can be expected that waves greater than the design wave could occur during severe storms and incur damages to the armor stone. It is estimated that the quantity of armor stone needing annual maintenance would be about one percent of the total quantity of armor stone required to construct the breakwater. Annual maintenance costs are shown in Appendix F.

NED FORM 225
27 Sept 49

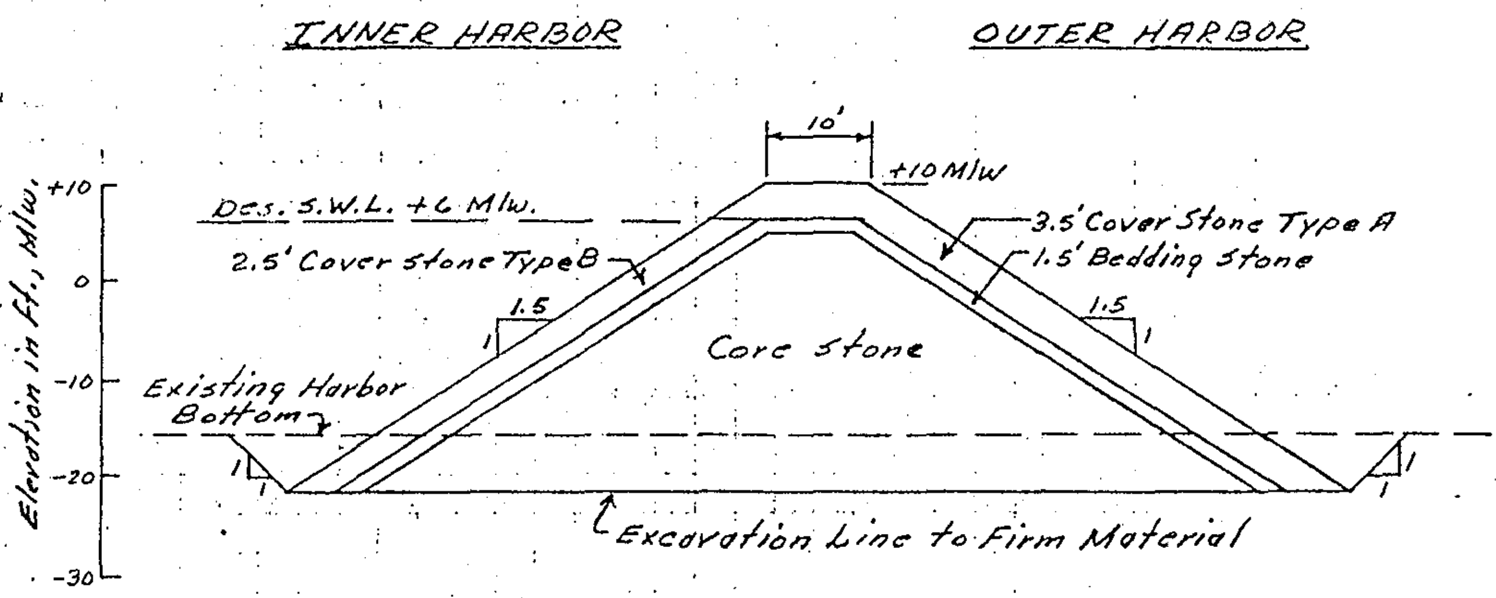
NEW ENGLAND DIVISION
CORPS OF ENGINEERS, U. S. ARMY

PAGE

SUBJECT BRISTOL HARBOR, R.I.

COMPUTATION

COMPUTED BY C.J.M. CHECKED BY DATE 11 Apr. 1980



TYPICAL BREAKWATER SECTION
PLANS A, B, C
Scale: 1" = 20'

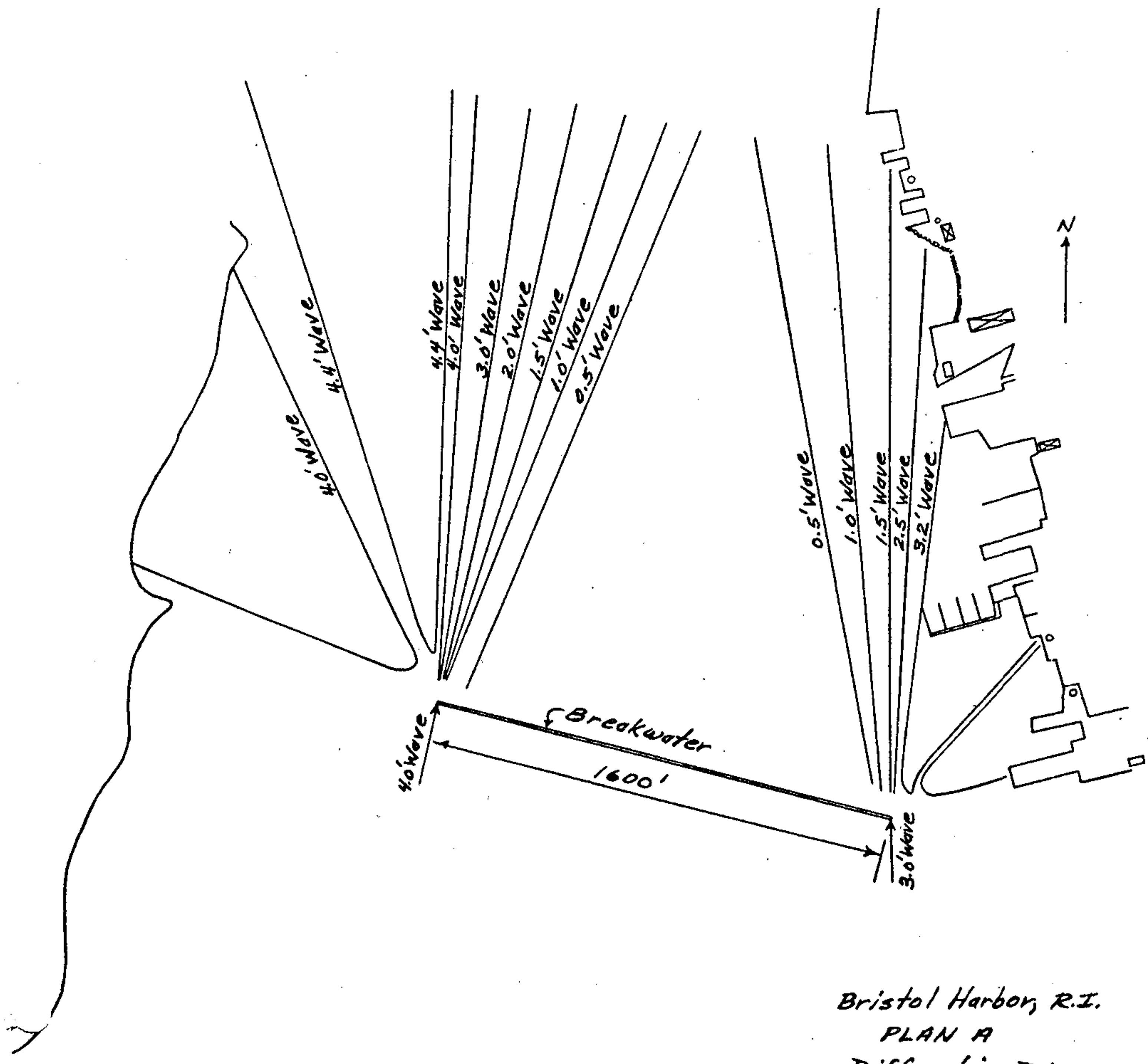
LEGEND

Cover Stone Type A - 350# to 600#

Cover Stone Type B - 175# to 300#

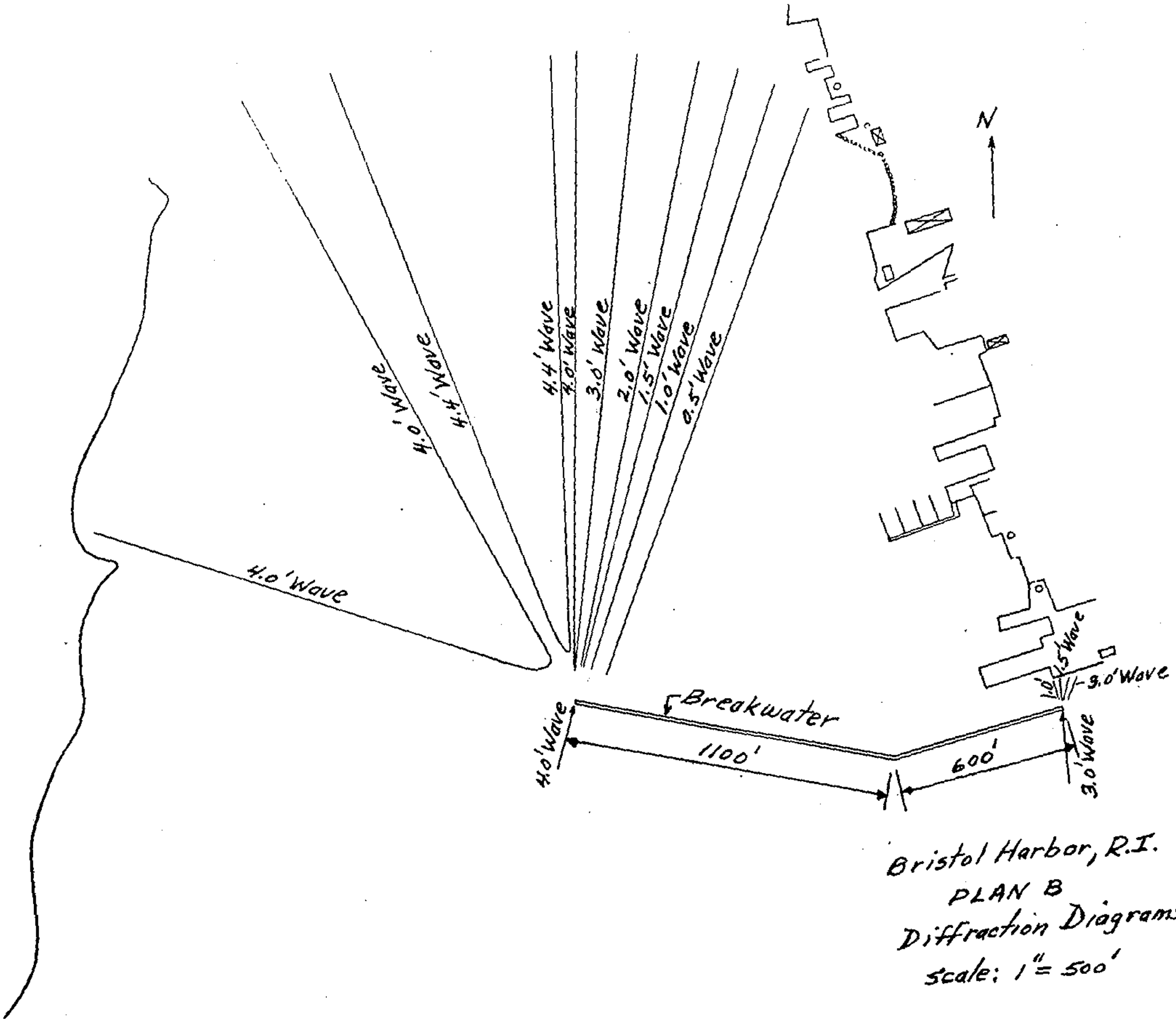
Bedding Stone - 40# to 75#

Core Stone - Quarry Spalls, 2# to 50#



Bristol Harbor, R.I.
PLAN A
Diffraction Diagrams
scale: 1" = 500'

PLATE D-2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4.0' Wave
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2.0' Wave
1.5' Wave
1.0' Wave
0.5' Wave
4.0' Wave
Breakwater
4.0' Wave
1100'
600'
3.0' Wave
1.5' Wave
1.0'
3.0' Wave
Bristol Harbor, R.I.
PLAN B
Diffraction Diagrams
scale: 1" = 500'

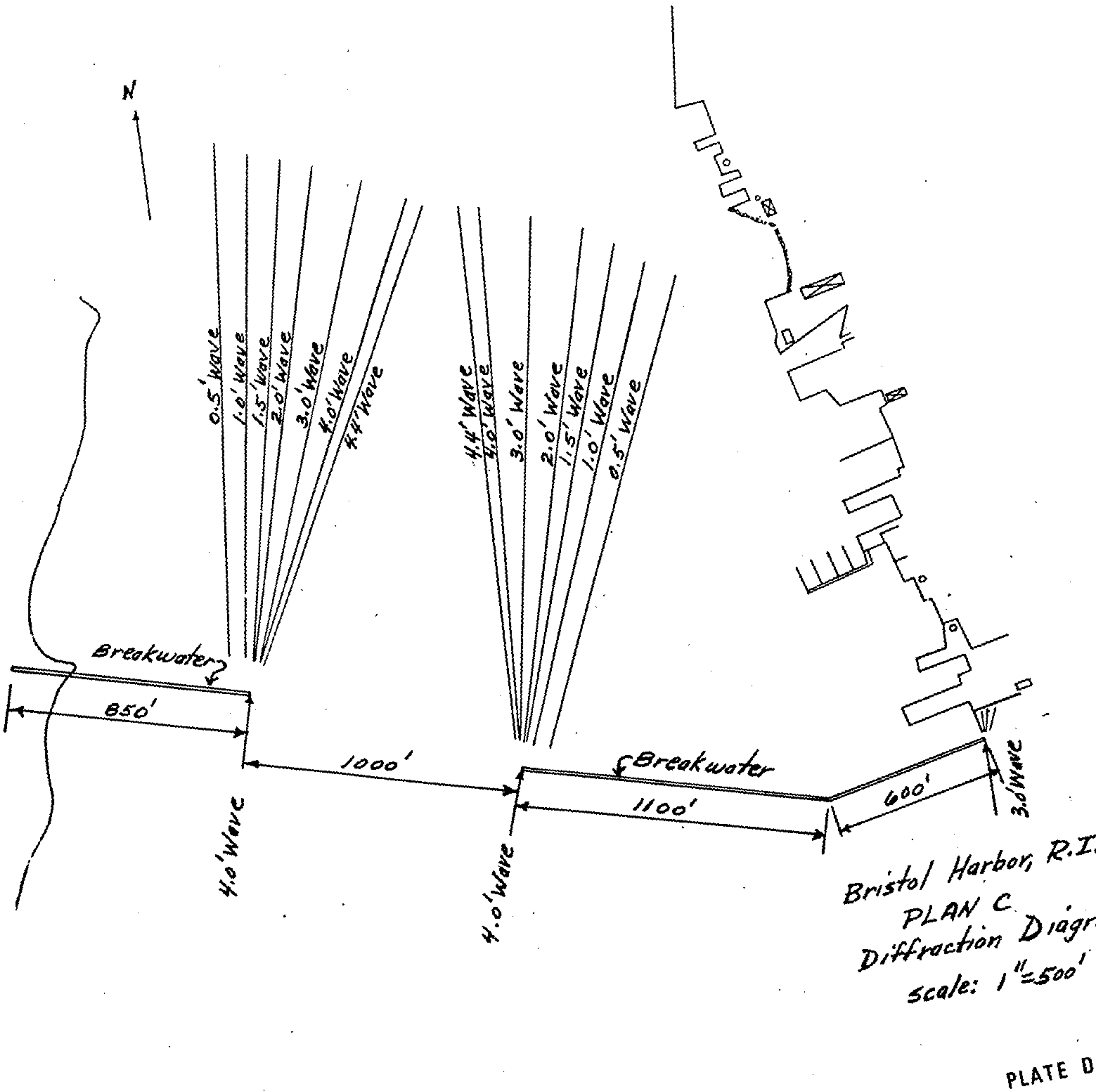
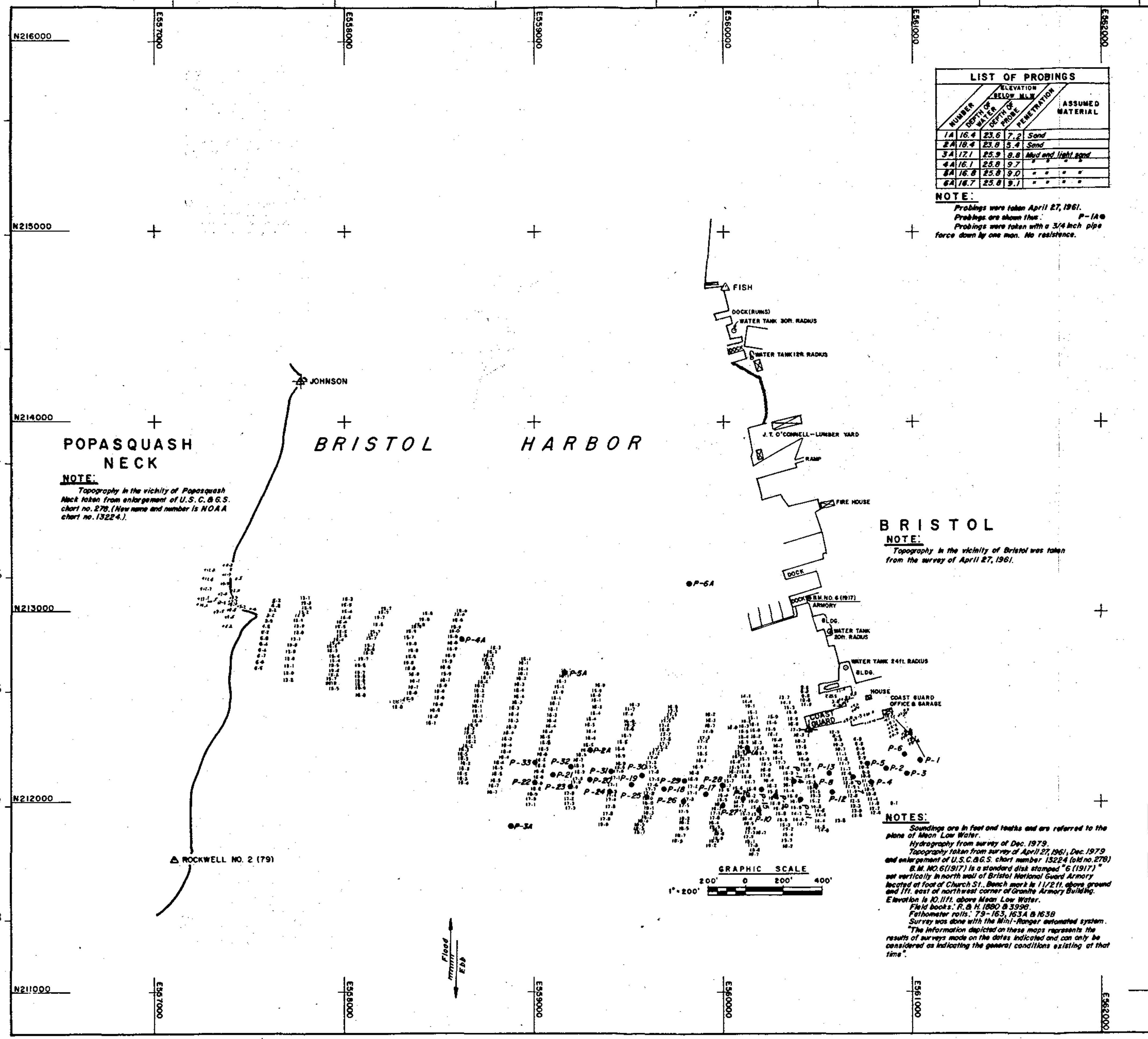

N
0.5' Wave
1.0' Wave
1.5' Wave
2.0' Wave
3.0' Wave
4.0' Wave
4.4' Wave
4.4' Wave
4.0' Wave
3.0' Wave
2.0' Wave
1.5' Wave
1.0' Wave
0.5' Wave
Breakwater
850'
1000'
Breakwater
1100'
600'
4.0' Wave
4.0' Wave
3.0' Wave
Bristol Harbor, R.I.
PLAN C
Diffraction Diagr
scale: 1" = 500'

PLATE D

CORPS OF ENGINEERS U. S. ARMY



NOTE:

Topography in the vicinity of Popasquash Neck taken from enlargement of U.S.C.&G.S. chart no. 278. (New name and number is NOAA chart no. 13224.)

NOTE:

Topography in the vicinity of Bristol was taken from the survey of April 27, 1961.

LIST OF PROBINGS

NUMBER	ELEVATION BELOW MLW: DEPTH OF WATER	ELEVATION BELOW MLW: DEPTH OF PROBE	PENETRATION	ASSUMED MATERIAL
1A	16.4	23.6	7.2	Sand
2A	18.4	23.8	5.4	Sand
3A	17.1	25.9	8.8	Mud and light sand
4A	16.1	25.8	9.7	" " " "
5A	16.8	25.8	9.0	" " " "
6A	16.7	25.8	9.1	" " " "

NOTE:

Probings were taken April 27, 1961.
Probings are shown thus: P-1A●
Probings were taken with a 3/4 inch pipe force down by one man. No resistence.

LIST OF PROBINGS

NUMBER	ELEVATION BELOW M.L.W.: DEPTH OF WATER	ELEVATION BELOW M.L.W.: DEPTH OF PROBE	PENETRATION	ASSUMED MATERIAL
1	2.3	2.5	0.2	Sand - Hard
2	7.4	7.6	0.2	" "
3	5.3	5.3	0.0	Rock - Gravel
4	11.8	12.3	0.5	Sand - Hard
5	10.4	10.4	0.0	Rock - Gravel
6	2.4	2.6	0.2	Sand - Hard
7	12.3	12.6	0.3	" - "
8	16.4	18.2	1.8	Sand - Soft to Hard
9	17.4	18.4	1.0	" - " " "
10	17.3	17.8	0.5	Sand - Hard
11	16.3	18.3	2.0	Sand - Soft to Hard
12	15.3	15.8	0.5	" - Hard
13	15.5	16.0	0.5	" - "
14	17.5	18.7	1.2	" - Soft to Hard
15	18.3	18.5	0.2	" - Hard
16	15.3	20.3	5.0	Mud - Soft to Hard
17	17.3	19.3	2.0	" - " " "
18	16.8	24.3	7.5	" - " " "
19	18.3	22.3	4.0	" - " " "
20	16.8	25.3	8.5	" - " " "
21	15.3	25.3	10.0	" - " " "
22	16.8	19.1	2.3	" - " " "
23	18.8	21.3	2.5	" - " " "
24	19.3	24.3	5.0	" - " " "
25	17.7	24.3	6.6	" - " " "
26	18.3	23.5	5.2	" - " " "
27	16.8	22.3	5.5	" - " " "
28	17.2	18.7	1.5	" - " " "
29	15.2	22.2	7.0	" - " " "
30	18.2	23.2	5.0	" - " " "
31	17.2	23.2	6.0	" - " " "
32	16.2	24.2	8.0	" - " " "
33	15.2	25.2	10.0	" - " " "

NOTE:

Probings were taken Feb. 12 & 13, 1981.
Probings are shown thus: P-1●
Probings were taken with a 1 inch aluminum probe pipe force down by one man.

NOTES:

Soundings are in feet and tenths and are referred to the plane of Mean Low Water.

Hydrography from survey of Dec. 1979.

Topography taken from survey of April 27, 1961, Dec. 1979 and enlargement of U.S.C.&G.S. chart number 13224 (old no. 278)

B.M. NO. 6 (1917) is a standard disk stamped "6 (1917)" set vertically in north wall of Bristol National Guard Armory located at foot of Church St.. Bench mark is 1 1/2 ft. above ground and 1 ft. east of northwest corner of Granite Armory Building. Elevation is 10.11 ft. above Mean Low Water.

Field books: R. & H. 1880 & 3998.

Fathometer rolls: 79-163, 163A & 163B

Survey was done with the Mini-Ranger automated system.

"The information depicted on these maps represents the results of surveys made on the dates indicated and can only be considered as indicating the general conditions existing at that time".

REVISION	DATE	DESCRIPTION	BY

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY / DR. BY / CK. BY
SUBMITTED: PROJECT MANAGER
REVIEWED: CHIEF, COAST. ENG./SUR. SECT.
APPROVAL RECOMMENDED: CHIEF, DESIGN BRANCH

BRISTOL HARBOR, RHODE ISLAND

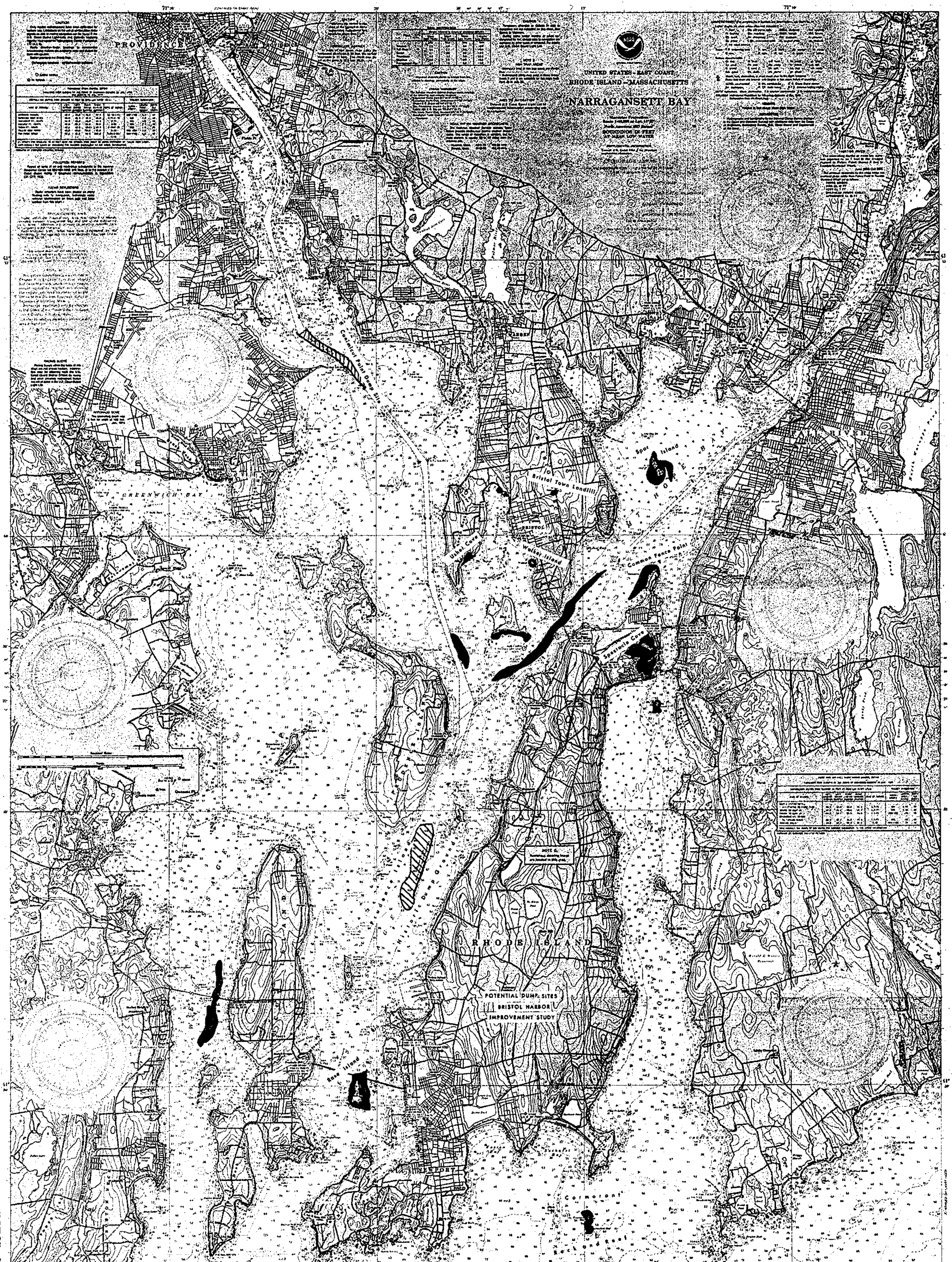
SUBSURFACE PROBINGS

PLAN-B

APPROVED ____ CHIEF, ENGINEERING DIVISION DATE ____

SCALE: 1"=200' SPEC. NO.
DRAWING NUMBER
SHEET OF

PLATE D-5



BRISTOL HARBOR, R.I.
PLATE D-6

BRISTOL HARBOR

BRISTOL, RHODE ISLAND

PHASE I AE&D

APPENDIX E

SOCIAL ANALYSIS

PREPARED BY
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

APPENDIX E

SOCIAL ANALYSIS

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APPENDIX E
SOCIAL ANALYSIS

INTRODUCTION

This phase of the Bristol Harbor Study will address the social and economic aspects of the proposed navigation improvements. The first part of this section will describe the study area, its population, economic, and land use characteristics. The second part will describe the "most probable future" of the study area without a project. The third part will describe the with project condition to be compared to the without to determine project impacts.

THE BASE CONDITION

A. Population

Bristol has shown significant growth since 1940, experiencing over a 10 percent growth for each interim decade. The county showed even greater growth over this period. The State continued to grow at a rate similar to the town and county between 1940 and 1950, but then for the decades between 1950 and 1970, showed a much smaller rate of increase, more than one half less than the town and county. Between 1970 and 1980 the town of Bristol showed an increase of 12.7 percent, with the county reporting a small increase in population of 2.2 percent and the State a small decrease of 0.3 percent. Population figures are given in Table 1.

TABLE 1
POPULATION

Year	Total	% Change from previous decade	Total	% Change from previous decade	Total	% Change from previous decade
1920	11,375				604,397	
1930	11,953	5.1	25,089		687,497	13.8
1940	11,159	- 6.6	25,548	1.8	713,346	3.8
1950	12,320	10.4	29,079	13.8	791,896	11.0
1960	14,570	18.3	37,146	27.7	859,488	8.5
1970	17,860	22.6	45,937	23.7	949,723	10.5
1980	20,128	12.7	46,942	2.2	947,154	- 0.3

The 1970 U.S. Census revealed that of the 17,860 residents in the town of Bristol, 3,324 (18.6 percent) were foreign born. Seventy-seven point eight percent of the foreign born in Bristol came from Portugal. The next largest group (9.8 percent) came from Italy.

B. Housing

The 1980 U.S. Census reported a total of 6,823 housing units in Bristol. This total is a 23.6 percent increase over the number of units recorded in the 1970 Census. Much of this increase was in single family homes. The 1970 statistics indicated that close to 60 percent of year round units were single family dwellings, about 20 percent were two family homes, and the remainder were 3 or more, with the exception of a very small percentage of mobile homes. These data are presented in Table 2.

TABLE 2
HOUSING, BRISTOL, R.I. 1970

Units per structure	Number	Percent
1	3,096	57.9
2	1.149	21.5
3 or 4	763	14.3
5 or more	331	6.2
mobile homes	5	0.1
Total (all year-round)	5,343	100.0

Of the occupied units, close to 65 percent were owner occupied. Approximately 4 percent of year-round units were vacant. Over half of these were available for sale or rent, indicating a vacancy rate of 2.2 percent for Bristol.

C. Economy

Data provided by Rhode Island Department of Employment Security show a total of 323 firms in Bristol in 1980. The manufacturing sector continued to provide more than 50 percent of employment opportunities. Table 3 shows the breakdown of employment by industrial sectors.

TABLE 3
EMPLOYMENT BY INDUSTRY
BRISTOL, RHODE ISLAND 1980

Industry	Number	% of Total
Agric., Fishing	53	1.4
Construction	256	6.6
Manufacturing	2,153	55.7
Trans., Comm., Util.	89	2.3
Wholesale Trade	44	1.1
Retail Trade	600	15.5
Finance, Insurance, Real Estate	57	1.5
Services	616	15.9
Total	3,868	100.0

According to data from the 1970 U.S. Census, Bristol had a total resident civilian labor force of 7,706, an increase of 25.1 percent from 1960. In 1970, 60 percent of the resident civilian labor force was male. The largest occupational group is operatives accounting for about 35 percent of the employed. The next largest group was sales and clerical workers making up 18 percent of the employment followed by craftsmen and foremen with 15 percent. Table 4 provides the breakdown of Bristol's employed residents among occupational groups.

TABLE 4
OCCUPATIONS OF EMPLOYED RESIDENTS
BRISTOL, R.I. 1970

Occupation	Number	Percent
Prof., Tech., Kindred	865	11.7
Managers, Administrators	376	5.1
Sales Workers	258	3.5
Clerical and Kindred	1,046	14.1
Craftsmen, Foremen, Kindred	1,106	14.9
Operatives	2,562	34.6
Laborers	426	5.8
Farmers, Farm Managers	38	0.5
Service Workers	655	8.8
Private household workrators	76	1.0
Total	7,408	100.0

Annual averages for 1980 indicate a labor force of 9,313 in Bristol. Unemployment averaged 804 for the year yielding an unemployment rate of 8.6 percent. The Providence-Pawtucket-Warwick Standard Metropolitan Statistical Area (SMSA), which includes Bristol, had a civilian labor force of 458,232 with 33,088 unemployed in 1980. Its unemployment rate was equal to Bristol's at 7.2 percent which equaled the State's rate.

The median family income for the town of Bristol in 1969, according to the 1970 Census, was $9,732. Median income for Bristol fell short of the county's $10,818, as well as the State's $9,736. Ten point nine percent of the families residing in Bristol earned under $4,000, with 15.2 percent earning over $15,000. When compared to the county, the SMSA, and the State, Bristol had the smallest proportion to Bristol County earning under $4,000. These data are presented in Table 5.

TABLE 5
INCOME, 1969

	Median	Percent Earning Under $4,000	Percent Earning Over $15,000
Bristol	$ 9,732	10.9	15.2
Bristol County	$ 10,818	9.2	26.5
PPW SMSA	$ 9,929	11.9	19.2
Rhode Island	$ 9,736	12.5	18.9

D. Land Use Characteristics

Bristol is an industrial town with three percent of its area in industrial and commercial land. Nearly one-third of this is a heavey industrial use. Of land developed in urban uses, residential acreage consumes the largest proportion, 23.6 percent. This is almost twice the State figure of 13 percent. Over one quarter of the residential land in Bristol is of high density (lots less than 1/4 acre in size), about one-half developed at medium density (lots from 1/4 to 1/2 acre in size) with the remaining portion in low density development (lot sizes from 1/2 to 1 acre).

Forest land, accounting for 30.1 percent of Bristol's land area, makes up the largest portion of non-urban land. Bristol has 26 percent of its area in agriculture, 19 percent of which is tilled and 7 percent which is either pasture or abandoned field. Table 6 provides a breakdown of Bristol's acreage in general land use categories.

TABLE 6
LAND USE, 1970
BRISTOL, RHODE ISLAND

Uses	Acres	Percent
Residential	1,609	23.6
Commercial	77	1.1
Industrial	129	1.9
Transportation	11	0.2
Open & Public	268	3.9
Outdoor Recreation	187	2.7
Agriculture	1,788	26.2
Forest Land	2,053	30.1
Wetlands	632	9.3
Mining, Waste Disposal	74	1.1
TOTAL	6,828	100.1

Source: William P. MacConnell, Remote Sensing Land Use and Vegetative Cover in Rhode Island

E. The Harbor

Land uses bordering the harbor are diverse. The harbor's east shore (north of the Coast Guard Station) has been developed in manufacturing with a mix of commercial, residential and some recreational uses interspersed. Away from the waterfront, high density residential development predominates. The harbor's west shoreline is occupied by several large private estates, the Bristol Marine Boat Yard and the Bristol Yacht Club.

Boating interests within the study area include recreational and commercial craft, the Prudence Island Ferry, and a U.S. Coast Guard Station. The harbor offers some facilities for the recreational and commercial boaters. There are two town-owned docking facilities on the east coast of the harbor, the Rockwell dock and the State Street dock. A third dock, the Church Street dock, is leased by the town from the State on a long term basis.

The Rockwell and Church Street docks accommodate approximately sixty boats. Slip space is leased through the town by both recreational boaters and fishermen. The State Street dock accommodates about 15 boats and is utilized by the larger fishing craft. Two municipal launching ramps are available for public use at the State Street dock and north at Independence Park. Boat launching facilities and a limited amount of docking space are offered on the west side of the harbor by Bristol Marine and the Bristol Yacht Club, which are restricted to private use.

THE WITHOUT PROJECT CONDITION

A. Future Population

Population projections prepared by the State Planning Office indicate that Bristol's population will peak at 22,400 in 2015 and remain at that level through 2025, declining to 22,200 by 2030. These projections provide for a growth of 9.3 percent between the 1985 population and the peak population of 22,400.

Although population is expected to continue growing, the rate of growth is anticipated to be much less than the rates experienced over earlier decades. Bristol's growth would continue to exceed that being experienced by the State. Table 7 displays the projections for the town, county, and State.

TABLE 7
POPULATION PROJECTIONS

	BRISTOL		BRISTOL COUNTY		RHODE ISLAND	
Year	Number	Percent Change from previous period	Number	Percent Change from previous period	Number	Percent Change from previous period
1985	20,500		48,300		960,300	
1990	21,300	3.9	49,400	2.3	978,000	1.8
1995	21,800	2.3	50,200	1.6	994,100	1.6
2000	22,100	1.4	50,800	1.2	1,005,600	1.2
2005	22,200	0.5	50,900	0.2	1,014,200	0.9
2010	22,300	0.5	51,200	0.6	1,023,300	1.0
2015	22,400	0.4	51,300	0.2	1,033,800	1.0
2020	22,400	0.0	51,400	0.2	1,041,700	0.8
2025	22,400	0.0	51,400	0.0	1,044,000	0.2
2030	22,200	-0.9	50,900	-1.0	1,040,000	-0.4

B. Future Growth and Development

The east coast of the harbor is currently zoned as a manufacturing district and has been developed as such. A new ordinance has been proposed to change the zoning from a manufacturing to a waterfront district to control and encourage development compatible to the waterfront location. The area would be developed in mixed uses including housing, stores, restaurants, and boating support services. Aesthetics and practical need would be emphasized.

The need for increased docking facilities exists. It is possible that new facilities may be provided at Independence Park. Restoration of past facilities is desired at the Elks Club and the mill complex; however, the unprotected nature of this area limits that potential.

The mill complex might eventually be converted to housing. A promenade or harbor walkway has also been considered, again encouraging aesthetics and enhancing the potential of the waterfront. It is expected that the private estates on the western coast of the harbor would be maintained and the area would remain much as it is today.

C. The Harbor

The harbor is presently exposed to storm waves from the southeast to southwest directions that have inhibited fleet growth and shorefront development. Damages to recreational craft and coastal establishments have resulted from the rough seas. The without condition is a continuation of destructive southeast to southwest seas and subsequent boat and shorefront damages. Economic losses and safety risks experienced by individual boaters would continue to discourage full utilization of the harbor. Two or three boats are repaired by local boatyards each year as a result of damages sustained in Bristol Harbor. It is believed that the actual number of damaged boats is higher, with many boat owners performing their own repairs. Damages to the existing fleet result in some loss of recreational usage to those individual boaters whose boats receive damage and discourage other boaters from assuming a similar risk by mooring in the harbor. The danger confronted by navigating somewhat rough waters with small dinghies to reach their craft discourages many boaters from enjoying the full boating potential.

Although a change in land use development along the east shore is being encouraged, damages would still be incurred by waterfront structures. Increases in the fleet and development of new docking facilities or marine support services would be limited.

THE WITH PROJECT CONDITION

The structural alternative under consideration for providing navigation improvements in Bristol Harbor is a breakwater. The construction of an offshore breakwater was authorized in 1968, but concern as to the optimum positioning of the breakwater yielded this study effort.

During this phase of the current study, three breakwater plans are being examined. They are as follows:

Plan A: A stone breakwater approximately 1600 feet long, beginning 400 feet west of the U.S. Coast Guard Station, and extending in a northwesterly direction.

Plan B: A stone breakwater 300 feet south of the U.S. Coast Guard Station, beginning about 400 feet from shore, running 600 feet west, then 1100 feet northwest.

Plan C: Same as Plan B, plus a stone breakwater extending 700 feet in a southeasterly direction from the west bank.

Nonstructural plans have also been considered. A detailed description of these plans is provided in the text.

As indicated in the introduction, the purpose of this report is to address the social and economic aspects of the proposed alternatives. The aspects or impacts addressed here have been designated as social well-being considerations. According to the Water Resources Council's Principles and Standards project effects on a community's social well-being can best be described as effects on health, safety, community well-being and effects on education, cultural, and recreational opportunities. Adverse effects on social well-being are indicated by community disruption or displacement of people or businesses resulting from project implementation.

These considerations are discussed below in the context of the two phases of project implementation, construction and post-construction. Impacts likely to occur during the construction phase generally are short term and site specific. Post-construction impacts are generally long term and can have regional as well as site specific implications.

A. Impacts of the Breakwater

1. Construction Phase

Transportation of materials and equipment to the project site is expected to be the major source of social impacts occurring during the construction phase. It is expected that the rock matrial necessary for the breakwater would be barged from Tiverton, Rhode Island or nearby quarries in Massachusetts to its ultimate location in the harbor. Some construction materials, however, could be trucked to the Coast Guard dock and loaded onto barges. For Plan C it would be necessary to truck materials to the west side of the harbor for the breakwater proposed there. The transport of materials by truck could hinder normal traffic flows along the shorefront. Noise, air and dust levels would increase. On the west side, access though private property would be required for trucks to reach the shorefront. The movement of barges and construction equipment in the harbor could temporarily interfere with boat traffic. Construction would take approximately 24 months. A small increase in temporary employment would also result from project construction.

2. Post-Construction Phase

Long term effects of project implementation would be felt by recreational boats and fishing craft that utilize the harbor, as well as the commercial establishments along the shorefront. The project would reduce exposure of the harbor to storms and rough seas originating in southerly quadrants. This protection would promote increased use of the harbor by the existing fleet, encourage the establishment of additional moorings, and reduce the physical damages to boats and shorefront structures. The economic benefits accruing to these interests are shown in Appendix F.

The protected harbor acreage differs with each of the breakwater alignments proposed in the structural plans previously identified. Plan A would protect 70 acres, Plan B 65 acres, and Plan C 150 acres. The economic analysis utilized a factor for mooring capacity of 7 boats per acre. This factor yields protected mooring capacity of 490 boats in Plan A, 455 in Plan B and 1,050 in Plan C.

The project would permit the existing fleet to more fully utilize the recreational potential of the harbor. The protection offered by the breakwater would reduce the safety risk faced by recreational boaters using small dinghies to reach their craft and increase their recreational opportunity. Plans A and B, however, would not provide direct protection to the existing fleet because the existing moorings would not be directly behind the breakwater. Nevertheless, a benefit would result from a reduction in wave action because of the presence of the breakwater. This reduction in wave action because of the presence of the breakwater. This reduction would provide boat owners a safer passage to and from their boats via dinghy allowing them increased recreational usage estimated at 10 percent over current usage. Plan C on the other hand does provide direct protection to approximately one half of the existing fleet, increasing their recreational opportunity by 20 percent to full utilization. The remaining half of the existing fleet would benefit the same as in Plans A and B.

The construction of the breakwater would lessen the economic risk faced by boat owners mooring in the harbor, and increase the appeal of the harbor to other boaters. Damages to boats as a result of storms and rough seas would be reduced. Boating time lost to making repairs would be regained. Without the threat of damages, the harbor would become a desirable mooring location for additional boaters. Plan A, protecting a total of 70 acres, would accommodate 490 boats. Since the existing fleet lies outside the protected area, this capacity of 490 would be filled by the creation of new moorings. Although it would be possible for the existing fleet to relocate their moorings within the protected area, it was assumed that very few would actually choose to do so. Plan B would provide protection for 455 moorings and boats which would be new growth. As in Plan A, the existing fleet lies outside of the protection. Under Plan C, capable of protecting 1,050 mooring spaces, the harbor would experience new growth totalling 925 boats, since one half of the existing fleet is located within the area that would be protected. The new moorings would result in increased tax revenues to the town. Further development of marine services or additional docking facilities would also benefit the local economy.

The project would also reduce the economic losses to shorefront establishments. Plans A and B would provide protection to those establishments on the eastern coast of the harbor. Those facilities on the shorefront that have experienced damages include the Prudence Island Ferry pier, Quito's and Gilbert's, fish wholesalers. Plan C would not only provide protection to those users in the east coast, but would also provide protection to the Bristol Marine and the Bristol Yacht Club on the west coast.

The navigation improvements recommended by the project complement the local planning needs of Bristol. As mentioned heretofore, the town of Bristol is encouraging shorefront development which is attractive to recreational boaters, including restaurants, shops and housing. Also the need and desire for more docking facilities would be encouraged by the proposed project. The Elks Club, originally the site of the Bristol Yacht Club, is interested in restoring some docking space; it would be unlikely to do so without the project. A fish wholesaler located within the mill complex has expresed interest for increased docking facilities, but again is unlikely to do so without protection.

Basically, any of the three structural plans being considered would benefit particular interests and the entire community as described above. Plan C, however, would offer the most extensive protection. It would protect half of the existing fleet, encourage new fleet growth of 925 boats and protect establishments on both the east and west sides of the harbor.

B. Impacts of Nonstructural Plan

1. Nonstructural Measures

Nonstructural alternatives were developed during the planning process. Several were considered for reducing boat and shoreline damages and increasing the recreational opportunity.

Nonstructural measures that would help to reduce boat damages include strengthening the moorings and mooring lines, storm warnings and removal of boats from the harbor, evacuation of boats to sheltered harbors, and shortening the boating season by removing boats prior to the hurricane season. Measures considered for reducing shoreline damages included reinforcing the docks, replacing docks with steel bulkheads or rock revetment, or removing docks altogether. Responding to the need for increased recreational boating opportunity, dry stacking of boats, the construction of additional boat launching ramps, and floating breakwaters were also suggested.

2. Construction Phase

Although the measures identified above are categorized as nonstructural solutions to the problems experienced in Bristol Harbor, some require structural modification and construction activity and therefore would have construction related impacts as described below.

Measures for reducing shoreline damages involve structural modifications to existing docks. These activities would increase noise and air pollution levels along the shoreline. Construction materials and equipment gaining access by land would congest the dock areas and may interfere with normal activities, temporarily reducing accessibility of some users.

Construction activities would also be required to provide for increased recreational boating facilities. The construction of any new facilities would be the total responsibility of non-Federal interests. Possible locations for providing for dry stacking are the Bristol Yacht Club, Bristol Marine, and Independence Park. The addition of boat launching ramps could also be considered at any of these locations. Development of these types of facilities would require both land and sea based construction activities. Impacts would be specific to the site. Transport of large amounts of materials however, would result in increased truck travel and congestion on local roads. Water based activities may present an additional navigation hazard within the mooring areas.

Measures suggested for reducing boat damages include a variety of relocation or removal schemes and would not have a "construction" phase and corresponding impacts. One measure, however, strengthening moorings and mooring lines would require the action of individual boat owners and would have minimal construction or implementation phase effects.

3. Post-Construction Phase

The nonstructural measures would have some long term effects experienced during the post-construction phase. These measures would provide some protection to the existing recreational boating fleet and shorefront interests. Although some opportunity for increasing recreational boating facilities exists, it is not certain that it would be realized since the nonstructural measures would have no effect on rough seas and winds. Therefore, the harbor's appeal for recreational boating would still be limited.

Strengthening the moorings and mooring lines would be effective in reducing boat damages, although a measure of the actual reduction would be difficult. Strengthening of the moorings would restrict the dragging of the mooring during rough conditions, and reduce the number of boats breaking loose, striking other boats, and running aground.

The removal schemes would also be effective in reducing damages. However, in two of the schemes, taking the boats out of the water and evacuating the boats to more sheltered harbors, an effective and timely warning system would be essential in order that boat owners have sufficient time to safely remove or relocate their boats without endangering their own lives. Shortening the boatng season would reduce the recreational enjoyment.

Reducing shoreline damages by structural modifications to or replacment of existing docks would permit the current level of activity to occur zoning without damages as is the existing condition.

The nonstructural measures, however, would not particularly enhance the appeal of the harbor or promote growth to its recreational potential. Even though stronger moorings would reduce damages, the risk of damages to boats mooring in the harbor would still exist. Boat owners would not experience an increased recreational opportunity as they would with adoption of a structural measure, since the strong winds and seas would persist, continuing to make passage of boaters from shore to their boats via dinghies dangerous. Removal of boats in response to storm warnings would present a personal risk and again would limit the full recreational potential of the harbor's boaters. As a means of protection, removal of boats would discourage fleet growth, denying the harbor's realization of its full recreational potential. It has already been recognized that the supply of mooring spaces is scarce, and the ability to relocate boats to a sheltered harbor would not only be inconvenient but also difficult.

BRISTOL HARBOR
BRISTOL, RHODE ISLAND

PHASE I AE & D

APPENDIX F

ECONOMIC ANALYSIS

PREPARED BY
THE DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

APPENDIX F
ECONOMIC ANALYSIS

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APPENDIX F
ECONOMIC ANALYSIS

I. INTRODUCTION

Storm and wind action originating from the south and southwest directions of Bristol Harbor preclude its transformation into a fully developed resource. Fleet growth and harbor development, beyond present levels, has not occurred and in some cases has been declining. Protection of Bristol Harbor from wind and wave forces would result in growth and greater utilization of the existing recreation fleet, damage reduction to the fleet, and damage reduction to shore facilities.

A. Without Project Conditions

At present, the difficulties in maintaining a boat in Bristol are such that boaters are unable to fully utilize the 150-day season that many other Rhode Island harbors enjoy. Travel from ship-to-shore is often difficult and dangerous when using the small dinghies needed get to and from the boats. Boat owners and yacht club personnel have the additional burden of keeping close watch during storm and wind conditions in order to prevent damages to boats. These factors cumulate to discourage and lessen the potential of the harbor.

Without the project, the existing fleet will not grow and may, in fact, decline. Each year an average of 2 to 3 large sailing boats are damaged, with total damages running approximately $10,000. Local repair yards believe the number of boats damaged may be significantly higher, because many boat owners perform their own repairs. Due to the high cost of coverage, some boat owners elect not to carry insurance, thereby taking a chance that their boats will not be damaged. Others do not report damages in order to avoid payment of large deductables on insurance.

Damages to town-owned facilities has discouraged the expansion of existing slips located on the east side of the bay. Additionally, two small fish wholesalers have suffered repeated damage to their buildigns which lie close to the water. If no protection is given, these businesses will continue at their present level of activity though both have expressed a desire to expand their operations.

B. Solutions to the Problem

Three detailed structural alternative plans have been proposed for navigation improvements in Bristol Harbor. They are rock breakwaters located at the site of the U.S. Coast Guard Station.

The alternative plans are briefly described as follows:

Plan A: A stone breakwater approximately 1,600 feet long, beginning 400 feet west of the U.S. Coast Guard Station and extending in a northwesterly direction.

Plan B: A stone breakwater 300 feet south of the U.S. Coast Guard Station running 600 feet west, then 1,000 feet in a northwesterly direction.

Plan C: A stone breakwater, the same as Plan B, with a 700-foot breakwater extending from the opposite shore.

C. With Project Conditions

Depending on which plan is considered, each breakwater proivdes a different area of protection. Plan A provides protection for 70 acres of harbor space. Plan B protects 65 acres, and Plan C protects 150 acres. The figures indicated above for Plan B and C represent the net space available for protected moorings after subtracting out Coast Guard access requirements. The mooring capacity is seven boats per acre in the harbor.

Presently, the average size of a boat in Bristol is slightly smaller than 25 feet, however, for the purpose of this analysis 25 feet is used. Officials at Bristol Yacht Club see a movement toward larger sailboats instead of powerboats due to high fuel costs and the increasng popularity of sailing. Multiplying the protected area of each plan by seven gives the total "protected" capacity of each. The "protected" capacities are 490, 455 and 1,050, respectively, for Plans A, B and C.

Presently the recreational fleet at Bristol is comprised of 250 boats, of which approximately 70 percent are powerboats and 30 percent are sailboats. Most of the boat owners belong to the Bristol Yacht Club, which currently has a membership of 275 people. Additionally, the town owns one boat ramp at Independence Park with parking facilities, which many small powercraft and sailboats use. According to the Town Planner, though no formal plan exists, there is an interest in developing the shorefront in a manner similar to Newport, where regular visitors and transients may browse, eat, and shop.

Based on conversations with the manager of the Bristol Yacht Club, the Harbormaster, and Bends Boatyard in Portsmouth, Rhode Island, the existing fleet could reasonably be expected to immediately expand by 150 boats with the implementation of any of the three plans. It is assumed that the composition of the immediate expansion will be the same as that of the existing fleet. An informal telephone survey was conducted of six marinas, and the yacht clubs and harbors within a 25 mile radius of Bristol. Everyone had a waiting list or was filled to capacity by 15 April. The forecast resulting from this survey is such that even beyond the immediate expansion, future growth is expected to continue at an average rate of 20 boats per year for each of the three plans until the respective capacities are reached. The composition of the future expansion is weighed more heavily toward sailboats to reflect the increasing preference for sail over powercraft.

A summary of the anticipated growth pattern for each of the three plans is shown in Table I below.

TABLE I
Anticipated Growth Pattern

PLAN	Existing Fleet: Unprotected By Project	Existing Fleet: Protected By Project	Fleet Growth (Protected by Project): Immediate	Fleet Growth (Protected by Project): Future	Time to Reach Capacity Years	Total Number of Boats
A	-	250	150	340	17	740
B	-	250	150	305	15	705
C	125	125	150	775	39	1,175

D. Recreational Boating Benefits

Recreational boating benefits are defined as values equal to the net return on the depreciated investment on the boat, after expenses, that owners would receive if their boats were let out for hire. The net return varies according to the type of boat and its size.

For the existing fleet of 250 boats, only 80 percent of the ideal benefits are assumed as presently being realized. This figure is taken to be uniform. Benefit computations are based on the following assumptions:

EXISTING FLEET (PLAN A) - The existing fleet (250 boats) will average 10 percent more usage, thus increasing usage from 80 percent of ideal to 90 percent of ideal. This assumption recognizes that few if any of the existing boats will lie in the fully protected area. Despite this fact, attenuation of spurious waves will occur on both sides of the breakwater. As a result, boaters will be able to row to and from their boats by dinghy in weather that would be inhibiting without the breakwater.

EXISTING FLEET (PLAN B) - The same assumptions hold as in Plan A.

EXISTING FLEET (PLAN C) - Half of the existing fleet (125 boats) will not be in the area fully protected by the improvement. Nevertheless, the attenuation effect on wave action will permit the usage level for these boats to reach 95 percent of ideal. The other half of the present fleet will lie in fully protected areas, thus attaining usage levels at 100 percent of ideal.

NEW MOORINGS (PLANS A, B & C) - All fleet increases, both immediate and future, will moor in fully protected areas, thus generating usage levels at 100 percent of ideal. Few, if any of the existing fleet are expected to transfer to fully protected area. This expected reluctance to transfer is based on:

(1) The desire to remain in close proximity to the yacht club
(2) The expense and bother involved in moving their mooring
(3) The likelihood that some improvement to the existing mooring location will occur even though it would not be in a fully protected zone.

A transient fleet was not included in the benefit analysis due to its small number and the relatively short stays anticipated in Bristol. Yacht club officials estimate a transient fleet of 175 to 200 boats, staying an averaging of three days each. Multiplying the number of boats by the average stay results in the number of boat days per year. Dividing this by the number of days in the boating season at Bristol results in a transient fleet average approximately four boats per day. Because any attempt at defining the class and size of the transients would be purely speculative and relatively insignificant in the final analysis, no benefit is evaluated.

Many of the boats in Bristol are large inboards and cruising sailboats which spend as much as 25 percent of their time away from port. Therefore the "on cruise" estimates in Table I thru VI are taken to be percentage of the season the boats are out of the harbor.

Tables II and III show the breakdown of the existing fleet and the anticipated benefits accruing to the breakwater after construction of Plans A, B, or C (see Pages F-5 and F-6). Table IV shows the anticipated growth and benefits of the expanded fleet immediately after construction of Plans A, B, or C (see Page F-7). Tables V, VI and VII show vessel composition and benefits for future expansion under Plans A, B and C, respectively, (see Pages F-8, F-9, F-10).

<u>The recreational boating benefits were originally prepared using October 1980 boat values, but were subsequent updated by 9.75 percent to reflect July 1981 price levels and are shown in Table X., Estimated Annual Benefits (see Page F-16).</u>

E. <u>Commerical Fishing Benefits</u>

BRISTOL AS A COMMERICAL FISHING PORT

<u>INSHORE FISHERY</u>

Commerical fishing in Bristol Harbor is presently limited to shellfishing of quahaugs, mussels and conch (snails).

The uncertain and speculative nature of the Conch market indicates that no significant benefit exists to that fishery. Conversations with Amoriggi Seafood of Johnston, Rhode Island, perhaps the largest dealer of shellfish in the State, informs us that public acceptance of Conch has not taken a

TABLE II

RECREATIONAL BOATING BENEFITS

EXISTING FLEET, PLANS A,B

HARBOR: BRISTOL R.I. — 1980 BOATING VALUES — BOATING SEASON: 150 DAYS

TYPE OF CRAFT	LENGTH (feet):	# OF BOATS	DEPRECIATED VALUES Average $	DEPRECIATED VALUES Totals $	PERCENT RETURN Ideal	% of Ideal Pres.	% of Ideal Fut.	Gain	VALUE $	ON CRUISE Avg. Days	ON CRUISE % of Season	ON CRUISE Value $
Outboards	10-14	10	3290	32900	14	80	90	1.4	461			
	15-20	92	4350	400200	13			1.3	5203			
	21&Up	0	8850	—	13			—	—			
Sterndrive	15-20	2	6700	13400	12			1.2	161			
	21-25	13	10850	141050	11			1.1	1552			
	26&Up	0	24200	—	10			—	—			
Inboards	15-20	3	7250	21750	12			1.2	261			
	21-30	40	17750	710000	12			1.2	8520	14	9	767
	31-40	7	47650	333550	11			1.1	3669	18	12	440
	41-50	3	98050	294150	10			1.0	2942	30	20	588
	51&Up	0	255800	—	9			—	—		30	
Cruising Sailboats	15-20	14	6100	85400	8			0.8	683			
	21-30	21	18450	387450	8			0.8	3100	8	5	155
	31-40	10	47050	470500	7			0.7	3294	24	16	527
	41&Up	5	93250	466250	6			0.6	2798	38	25	700
Daysailers	8-15	5	2150	10750	12			1.2	129			
	16-20	5	3800	19000	12			1.2	228			
	21-25	15	6300	94500	11			1.1	1040	8	5	52
	26&Up	5	11500	57500	10	80	90	1.0	575	38	25	144
TOTALS		250		3538350					34616			3373

BENEFIT TO EXISTING FLEET = 31243

say $31200

TABLE III

RECREATIONAL BOATING BENEFITS

EXISTING FLEET, PLAN C

HARBOR: BRISTOL R.I. — 1980 BOATING VALUES — BOATING SEASON: 150 DAYS

TYPE OF CRAFT	LENGTH (feet):	# OF BOATS	DEPRECIATED VALUES Average $	DEPRECIATED VALUES Totals $	PERCENT RETURN Ideal	% of Ideal Pres.	% of Ideal Fut.	Gain	VALUE $	ON CRUISE Avg. Days	% of Season	Value $
Outboards	10-14	10	3290	32900	14	80	97.5	2.45	806			
	15-20	92	4350	400200	13			2.28	9125			
	21&Up	0	8850	—	13			—	—			
Sterndrive	15-20	2	6700	13400	12			2.10	281			
	21-25	13	10850	141050	11			1.93	2722			
	26&Up	0	24200	—	10			—	—			
Inboards	15-20	3	7250	21700	12			2.10	456			
	21-30	40	17750	710000	12			2.10	14900	14	9	1341
	31-40	7	47650	333550	11		*	1.93	6438	18	12	773
	41-50	3	98050	294150	10			1.75	5148	30	20	1030
	51&Up	0	255800	—	9			—	—		30	
Cruising Sailboats	15-20	14	6100	85400	8			1.40	1196			
	21-30	21	18450	387450	8			1.40	5424	8	5	271
	31-40	10	47050	470500	7			1.23	5787	24	16	926
	41&Up	5	93250	466250	6			1.05	4896	38	25	1224
Daysailers	8-15	5	2150	10750	12			2.10	226			
	16-20	5	3800	19000	12			2.10	399			
	21-25	15	6300	94500	11			1.93	1824	8	5	91
	26&Up	5	11500	57500	10	80	97.5	1.75	1006	38	25	252
TOTALS		250		3538350					60634			5908

* The 97.5% figure is based on the assumption that half the existing fleet (125 boats) will become fully protected (100% of ideal) and the other half (125 boats) will improve to about 95% of ideal. On average then, the improvement will be 97.5%

BENEFIT TO EXISTING FLEET = 54726

say $54700

TABLE IV

RECREATIONAL BOATING BENEFITS

IMMEDIATE FLEET EXPANSION, PLANS A, B, C

HARBOR: BRISTOL R.I. 1980 BOATING VALUES BOATING SEASON: 150 DAYS

TYPE OF CRAFT	LENGTH (feet):	# OF BOATS	DEPRECIATED VALUES Average $	Totals $	PERCENT RETURN Ideal	% of Ideal Pres.	Fut.	Gain	VALUE $	ON CRUISE Avg. Days	% of Season	Value $
Outboards	10-14	6	3290	19740	14		100	14	2764			
	15-20	54	4350	234900	13			13	30537			
	21&Up	0	8850	—	13			—	—			
Sterndrive	15-20	2	6700	13400	12			12	1608			
	21-25	8	10850	86800	11			11	9548			
	26&Up	0	24200	—	10			—	—			
Inboards	15-20	2	7250	14500	12			12	1740			
	21-30	23	17750	408250	12			12	48990	14	9	4409
	31-40	5	47650	238250	11			11	26208	18	12	3145
	41-50	2	98050	196100	10			10	19610	30	20	3922
	51&Up	0	255800	—	9			—	—		30	
Cruising Sailboats	15-20	9	6100	54900	8			8	4392			
	21-30	12	18450	221400	8			8	17712	8	5	886
	31-40	6	47050	282300	7			7	19761	24	16	3162
	41&Up	3	93250	279750	6			6	16785	38	25	4196
Daysailers	8-15	3	2150	6450	12			12	774			
	16-20	3	3800	11400	12			12	1368			
	21-25	9	6300	56700	11			11	6237	8	5	312
	26&Up	3	11500	34500	10		100	10	3450	38	25	863
TOTALS		150		2159340					211484			20895

BENEFITS TO IMMEDIATELY EXPANDED FLEET = 190589

say \$ 190600

TABLE V

RECREATIONAL BOATING BENEFITS

FUTURE FLEET — PLAN A

HARBOR: BRISTOL R.I. 1980 BOATING VALUES BOATING SEASON: 150 DAYS

TYPE OF CRAFT	LENGTH (feet):	# OF BOATS	DEPRECIATED VALUES Average $	DEPRECIATED VALUES Totals $	PERCENT RETURN Ideal	% of Ideal Pres.	% of Ideal Fut.	Gain	VALUE $	ON CRUISE Avg. Days	ON CRUISE % of Season	ON CRUISE Value $
Outboards	10-14	14	3290	46060	14		100	14	6448			
	15-20	121	4350	526350	13			13	68426			
	21&Up	0	8850	—	13			—	—			
Sterndrive	15-20	3	6700	20100	12			12	2412			
	21-25	15	10850	162750	11			11	17903			
	26&Up	0	24200	—	10			—	—			
Inboards	15-20	3	7250	21750	12			12	2610			
	21-30	51	17750	905250	12			12	108630	14	9	9777
	31-40	9	47650	428850	11			11	47174	18	12	5661
	41-50	3	98050	294150	10			10	29415	30	20	5883
	51&Up	0	255800	—	9			—	—		30	
Cruising Sailboats	15-20	26	6100	158600	8			8	12688			
	21-30	31	18450	571950	8			8	45756	8	5	2288
	31-40	14	47050	658700	7			7	46109	24	16	7377
	41&Up	7	93250	652750	6			6	39165	38	25	9791
Daysailers	8-15	7	2150	15050	12			12	1806			
	16-20	9	3800	34200	12			12	4104			
	21-25	20	6300	126000	11			11	13860	8	5	693
	26&Up	7	11500	80500	10		100	10	8050	38	25	2013
TOTALS		340		4703010					454556			43483

BENEFITS TO FUTURE FLEET = 411073

Say $411000

TABLE VI

RECREATIONAL BOATING BENEFITS

FUTURE FLEET, PLAN B

HARBOR: BRISTOL R.I. 1980 BOATING VALUES BOATING SEASON: 150 DAYS

TYPE OF CRAFT	LENGTH (feet):	# OF BOATS	DEPRECIATED VALUES Average $	DEPRECIATED VALUES Totals $	PERCENT RETURN Ideal	% of Ideal Pres.	% of Ideal Fut.	Gain	VALUE $	ON CRUISE Avg. Days	ON CRUISE % of Season	ON CRUISE Value $
Outboards	10-14	12	3290	39480	14		100	14	5527			
	15-20	109	4350	474150	13			13	61640			
	21&Up	0	8850	0	13			13	—			
Sterndrive	15-20	3	6700	20100	12			12	2412			
	21-25	13	10850	141050	11			11	15516			
	26&Up	0	24200	0	10			10	—			
Inboards	15-20	3	7250	21750	12			12	2610			
	21-30	41	17750	727750	12			12	87330	14	9	7860
	31-40	7	47650	333550	11			11	36691	18	12	4403
	41-50	2	98050	196100	10			10	19610	30	20	3922
	51&Up	0	255800	0	9			9	—		30	
Cruising Sailboats	15-20	24	6100	146400	8			8	11712			
	21-30	30	18450	553500	8			8	44280	8	5	2214
	31-40	13	47050	611650	7			7	42816	24	16	6851
	41&Up	7	93250	652750	6			6	39165	38	25	9791
Daysailers	8-15	7	2150	15050	12			12	1806			
	16-20	9	3800	34200	12			12	4104			
	21-25	18	6300	113400	11			11	12474	8	5	624
	26&Up	7	11500	80500	10		100	10	8050	38	25	2013
TOTALS		305		4161380					395743			37678

BENEFITS TO FUTURE FLEET = 358065

Say $358100

TABLE VII

RECREATIONAL BOATING BENEFITS

FUTURE FLEET, PLAN C

HARBOR: BRISTOL R.I. 1980 BOATING VALUES BOATING SEASON: 150 DAYS

TYPE OF CRAFT	LENGTH (feet):	# Of BOATS	DEPRECIATED VALUES Average $	DEPRECIATED VALUES Totals $	PERCENT RETURN Ideal	% of Ideal Pres.	% of Ideal Fut.	Gain	VALUE $	ON CRUISE Avg. Days	ON CRUISE % of Season	ON CRUISE Value $
Outboards	10-14	31	3290	101990	14		100	14	14279			
	15-20	268	4350	1165800	13			13	151554			
	21&Up	0	8850	—	13			13	—			
Sterndrive	15-20	8	6700	53600	12			12	6432			
	21-25	30	10850	325500	11			11	35805			
	26&Up	0	24200	—	10			10	—			
Inboards	15-20	8	7250	58000	12			12	6960			
	21-30	116	17750	2059000	12			12	247080	14	9	22237
	31-40	22	47650	1048300	11			11	115313	18	12	13838
	41-50	8	98050	784400	10			10	78440	30	20	15688
	51&Up	0	255800	—	9			9	—		30	
Cruising Sailboats	15-20	60	6100	366000	8			8	29280			
	21-30	76	18450	1402200	8			8	112176	8	5	5609
	31-40	31	47050	1458550	7			7	102099	24	16	16336
	41&Up	16	93250	1492000	6			6	89520	38	25	22380
Daysailers	8-15	16	2150	34400	12			12	4128			
	16-20	22	3800	83600	12			12	10032			
	21-25	47	6300	296100	11			11	32571	8	5	1629
	26&Up	16	11500	184000	10		100	10	18400	38	25	4600
TOTALS		775		10913440					1054069			102317

BENEFITS TO FUTURE FLEET = 951752

say $951752

strong hold. Until such time that consumer attitudes towards Conch change, a net increase in catch is not likley.

As for quahaugging, there does not seem to be any predictable relationships between the proposed breakwater plans and this industry's future. Rather, the quahaug fishery is sensitive to pollution, the general state of the economy and, of course, the resource limit.

OFFSHORE FISHERY

Bristol is not considered to be an attractive location for an offshore fishing port. Its location is considered to be too costly in terms of the steaming time and fuel cost. There are not now adequate port facilities in Bristol and no strong seafood industry. Essentially, developing Bristol as a commerical fishing port would involve starting from scratch. Many feel that Rhode Island has a surplus of potential fishing ports although it is admitted that most of them are not well developed for commerical fishing operations and/or are overcrowded.

Bristol Harbor would certainly be improved, however, with a breakwater. A breakwater would possibly act as a stimulus for the building of docks. Because of shifting price structures it is not possible to say if or at what rate Bristol would develop as a commmerical fishing port. Boats would land harvests at Bristol if prices warranted it. Landings would move from port to port on a seasonal (shifting price) basis. Alternative ports would, for example, include New Bedford, Stonington, Montauck Point, Newport, Fall River, Point Judith, etc. New England vessels have traditionally stayed close to their home port but that tradition is beginning to change. Bristol also represents a possible future for Ocean (Mahogony) Quahaugs.

STONINGTON SEAFOOD PRODUCTS PROPOSAL

Stonington Seafood Products (SSP) filed a report dated June 1, 1981, with the New England Division, U.S. Army Corps of Engineers indicating their desire to enter into a joint venture (GIFA) with Sweden provided a breakwater is built at Bristol. In essence the report states that if a breakwater is built in Bristol, a fleet of approximately 12-15 idle Gulf Coast shrimpboats will be home ported in Bristol Harbor. As part of the U.S./Swedish joint fishing venture these boats would engage in harvesting hake and delivering the harvest to two Swedish processing vessels deployed in the fishing grounds. The product after initial processing would be frozen and shipped to an eastern European country for completion of processing and distribution through an established marketing system. No fish would actually be landed in Bristol. The Gulf coast shrimpboats would only berth in Bristol Harbor.

The Stonington Seafood proposal does illustrate the type of commercial fishing development that might occur under the with-project condition. Although the construction of breakwater at Bristol does not appear to be a necessary condition for large scale exploitation of the silver hake fishery, it does appear to be a necessary factor for Bristol to complete for an offshore fishing fleet. Granted, the breakwater by itself does not provide a sufficient condition for Bristol to be a fishing port. While a breakwater might well act as a catalyst for attracting a fishing fleet to Bristol, a number of ancilliary services are also required, such as, marketing, offloading faciliites, ice, fuel, ships store, repair facilities, transporation, sewage disposal, water supply, electricity, etc.

An analysis of the Stonington Seafood proposal which includes the incorporation of its probability of being implemented and continuance is shown in the Supplemental Economic Analysis of Estimated Commerical Fishing Bnefits in Appendix G. The final computed benefit of $153,000 is felt to be indicative of the offshore fishery potential at Bristol under the with-project condition for Plans B and C which would give full protection to the proposed fish pier area at the town marina (State Armory). Plan A, however, would only provide protection an estimated two-thirds of the time based on its configuration. Thus, two-thirds of the $153,000 benefit equal to $102,000 is claimed for Plan A.

F. Damage Prevented Benefits

Damage estimates for the recreational fleet were derived from conversations with Bristol Marine, where most repairs in Bristol Harbor are done. Each year, two to three boats are damaged with total damages running approximately $10,000. Since all damages are not reported, but instead are repaired by the owners themselves, the estimate of $10,000 is considered conservative.

The U.S. Coast Guard Pier sustains physical damages during storms and measures are taken to avoid damage to their 180-foot buoy tender and other smaller vessels. When storms arise, the boats are moved to Mt. Hope Bay or Greenwich Cove in E. Greenwich, Rhode Island, where they wait out the storm. Damages to the pier include replacing the timber piles, repairing the concrete deck, granite walls, service utilities, etc. Annual benefits with Plans B or C are estimated to be $18,000.

Damage estimates for large commercial boats were not taken for the purpose of this study. Although several commercial boats (30′ - 40′) are located in the harbor, damage sustained is minimal. When severe storms arise, the boats can be moved to Tiverton Harbor. However, this rarely occurs, hence expenses incurred in moving the boats is considered not to be significant. In addition, several large fishing boats are owned by local wholesalers, Quito′s and Gilberts. However, they now dock at the Fisherman′s Cooperative in Galilee, Point Judith, Rhode Island. A move back to Bristol at this time would not be economically advantageous in view of rising energy costs and the time spent cruising back up to the harbor after the days fishing.

Small commercial shellfishing craft damage estimates were not included in the benefit-cost ratio. Due to the sturdy construction of the boats and the simple gear which is taken home at the end of the day, damages for these small vessels are assumed to be zero. When storms or strong winds do arise these boat owners either pull the boats out of the water or sink the boats without the outboard motors and retrieve them later.

The shore facilities which are damaged are located on the east and west shore of Bristol Harbor. Damage estimates were made by interviewing those affected by storms and obtaining information on historic repairs and maintenance. On the east side, the Prudence Island Ferry has had its sand filled pier washed out several times. Fish wholesalers, Quito and Gilbert, suffer damages annually due to the fact that they lie exposed to the water. Estimated annual damage prevention benefits to the ferry pier, Gilberts and Quitos are $5,000, $3,000 and $7,000, respectively.

Bristol Yacht Club, Bristol Marine and several private docks and piers are located on the west shore of Bristol Harbor. Annual damage prevented to these is estimated at $5,400 with total protection.

In total, there are 15,000 linear feet of shoreline located behind the purposed barriers. Of this amount, 6,400 linear feet is riprap stone. The remainding 8,600 feet is unprotected sand bank with the surface being grassed and landscaped. Plan C would reduce wave action to a minimum amount where it would cause almost no damage. Annual maintenance savings on riprap and bank restoration expenses are estimated to be $37,400. Therefore, the total annual benefit for the west shore structures and shoreline is $43,000 under Plan C, the optimum case. With Plans A and B, however, the maintenance costs saved are expected to be less and are estimated at $30,000 and $35,000, respectively.

Table VII provides a detailed breakdown of the damages which would be prevented by each plan. These damages prevented are considered project benefits. The existing recreational fleet is protected to about the same extent under all plans, therefore it is listed once.

TABLE VIII

Damages Prevented

Recreational Craft	$10,000
Existing Recreational Fleet (2 to 3 boats damaged per year)	
Shore Facilities	
Plan A	
a. Gilbert's Seafood	3,000
b. Quito's Seafood	7,000
c. Prudence Island Ferry Pier	5,000
d. West Shore Structures & Shoreline	30,000
	$45,000
Plan B	
a. Gilbert's Seafood	3,000
b. Quito's Seafood	7,000
c. Prudence Island Ferry Pier	5,000
d. U.S. Coast Guard	18,000
e. West Shore Structures & Shoreline	35,000
	$68,000
Plan C	
a. Gilbert's Seafood	3,000
b. Quito's Seafood	7,000
c. Prudence Island Ferry Pier	5,000
d. U.S. Coast Guard	18,000
e. West Shore Structures & Shoreline	43,000
	$76,000

II. ECONOMIC JUSTIFICATION

A. Estimated First Cost

Estimated first cost for each of the alternative plan have been developed and are presented in Table IX. They are based on July 1981 local construction costs.

TABLE IX
Estimated First Costs

Plan A

Construction and Materials	$4,385,000
Contingencies, 15%	657,000
Total Construction Costs	$5,043,000
Engineering and Design, 5%	252,000
Supervision and Administration, 7%	353,000
Aids to Navigation	6,000
TOTAL FIRST COST	$5,654,000

Plan B

Construction and Materials	$4,527,000
Contingencies, 15%	679,000
Total Construction Costs	$5,206,000
Engineering and Design, 5%	260,000
Supervision and Administration, 7%	365,000
Aids to Navigation	6,500
TOTAL FIRST COST	$5,837,500

Plan C

Construction and Materials	$6,141,300
Contingencies, 15%	921,200
Total Construction Costs	$7,063,000
Engineering and Design, 5%	353,000
Supervision and Administration, 7%	495,000
Aids to Navigation	9,500
TOTAL FIRST COST	$7,920,500

B. Estimated Annual Benefits

A summary of the estimated annual benefits for each plan is shown in Table X.

TABLE X
Estimated Annual Benefits

	3-1/4%	7-5/8%
Plan A		
Increased Use of Existing Fleet	34,000	34,000
New Boats (Immediate)	209,000	209,000
New Boats (Future)	329,000	216,000
Reduced Damages to Boats	10,000	10,000
Reduced Damages to Shore Facilities	45,000	45,000
Commercial Fishing	102,000	102,000
TOTAL	729,000	666,000
Plan B		
Increased Use of Existing Fleet	34,000	34,000
New Boats (Immediate)	209,000	209,000
New Boats (Future)	298,000	246,000
Reduced Damages to Boats	10,000	10,000
Reduced Damages to Shore Facilities	68,000	68,000
Commercial Fishing	153,000	153,000
TOTAL	772,000	720,000
Plan C		
Increased Use of Existing Fleet	60,000	60,000
New Boats (Immediate)	209,000	209,000
New Boats (Future)	496,000	346,000
Reduced Damages to Boats	10,000	10,000
Reduced Damages to Shore Facilities	76,000	76,000
Commercial Fishing	153,000	153,000
TOTAL	1,004,000	854,000

C. Apportionment of Benefits

The economic benefits attributable to the proposed breakwater are summarized according to Type, and are apportioned as local or general, as show in Table XI.

TABLE XI
Apportionment of Benefits

	Local	General	Total
Plan A			
3-1/4%			
Recreational	286,000	286,000	572,000
Commerical	0	102,000	102,000
Damages	0	55,000	55,000
	286,000	443,000	729,000
Percent of Total	39%	61%	100%
7-5/8%			
Recreational	254,500	254,500	509,000
Commerical	0	102,000	102,000
Damages	0	55,000	55,000
	254,000	411,500	666,000
Percent of Total	38%	62%	100%
Plan B			
3-1/4%			
Recreational	270,500	270,500	541,000
Commerical	0	153,000	153,000
Damages	0	78,000	78,000
	270,500	501,500	772,000
Percent of Total	35%	65%	100%
7-5/8%			
Recreational	244,500	244,500	489,000
Commerical	0	153,000	153,000
Damages	0	78,000	78,000
	244,000	475,500	720,000
Percent of Total	34%	66%	100%

TABLE XI (Cont.)
Apportionment of Benefits

	Local	General	Total
Plan C			
3-1/4%			
Recreational	382,500	382,500	765,000
Commerical	0	153,000	153,000
Damages	0	86,000	86,000
	382,500	621,500	1,004,000
Percent of Total	38%	62%	100%
7-5/8%			
Recreational	307,500	307,500	615,000
Commerical	0	153,000	153,000
Damages	0	86,000	86,000
	307,500	546,500	854,000
Percent of Total	36%	64%	100%

D. Estimated Annual Costs

Annual costs for each of these alternatives were calculated at discount rates of 3-1/4, and 7-5/8 percents respectively over a project life of 50 years. The 3-1/4 percent interest rate was mandated at the time of project authorization by Congress. Comparison of annual costs are shown in Table XII.

TABLE XII
Estimated Annual Costs

CFR	3-1/4% (.04073)	7-5/8% (.07823)
Plan A		
Federal		
Corps of Engineers		
I&A (61% x 5,648,000 = 3,445,280 x i)	$140,326	$ 0
(62% x 5,648,000 = 4,502,760 x i)	0	273,942
O&M Armor Stone (.01 x 1,097,170)	11,000	11,000
U.S. Coast Guard		
I&A (61% x 6,000 x i)	300	0
(62% x 6,000 x i)	0	500
O&M (Lump Sum)	1,700	1,700
Non-Federal		
I&A (39% x 5,648,000 = 2,202,720 x i)	104,188	0
(38% x 5,648,000 = 2,146,240 x i)	0	167,900
O&M	0	0
	$257,514	$455,042
Say	$258,000	$455,000

TABLE XII (Cont.)
Estimated Annual Costs

	3-1/4% CFR (.04073)	7-5/8% (.07823)
Plan B		
Federal		
Corps of Engineers		
I&A (65% x 5,831,000 = 3,790,150 x i)	$154,372	$ 0
(66% x 5,831,000 = 3,848,460 x i)	0	301,060
O&M Armor Stone (.01 x 1,150,341)	11,500	11,500
U.S. Coast Guard		
I&A (6,500 x i)	260	0
(6,500 x i)	0	500
O&M (Lump Sum)	1,650	1,650
Non-Federal		
I&A (35% x 5,831,000 = 2,040,850 x i)	83,124	0
(34% x 5,831,000 = 1,982,540 x i)	0	155,094
O&M	0	0
	$250,546	$469,800
Say	$251,000	$470,000
Plan C		
Federal		
Corps of Engineers		
I&A (62% x 7,911,000 = 4,904,820 x i)	$199,774	$ 0
(64% x 7,911,000 = 5,063,040 x i)	0	396,080
O&M Armor Stone (.01 x 1,588,770)	16,000	16,000
U.S. Coast Guard		
I&A (9,500 x i)	400	0
(9,500 x i)	0	800
O&M (Lump Sum)	2,500	2,500
Non-Federal		
I&A (38% x 7,911,000 = 3,006,180 x i)	122,442	0
(38% x 7,911,000 = 2,847,960 x i)	0	222,790
O&M	0	0
	$341,116	$638,178
Say	$341,000	$638,000

E. Benefit-Cost Ratio

For any plan to warrant Federal participation, a benefit-cost ratio of at least unity must be obtained. Dividing the annual benefits by the annual cost results in the benefit-cost ratio. The analysis has been performed for discount rates of 3-1/4 and 7-5/8 percent, respectively. The 3-1/4 percent discount rate is that used for the original project authorization. This was the standard rate used prior to 24 December 1968. The benefit-cost ratios for each plan are shown in Table XIII.

TABLE XIII
Benefit-Cost Ratios

	Rate	Annual Benefits	Annual Costs	Benefit-Cost Ratio	Net Benefit
Plan A	3-1/4	729,000	258,000	2.83	471,000
Plan B	3-1/4	772,000	251,000	3.08	521,000
Plan C	3-1/4	1,004,000	341,000	2.94	663,000
Plan A	7-5/8	666,000	455,000	1.46	211,000
Plan B	7-5/8	721,000	470,000	1.53	251,000
Plan C	7-58	854,000	638,000	1.34	216,000

F. Apportionment of Costs Among Interests

Costs for the improvement under consideration have been apportioned between the United States and local interests so that the Federal and non-Federal share of the first cost of construction are in the same ratio as the evaluated general and local benefits. The first cost of construction of the breakwaters and Federal and non-Federal investments resulting from this apportionment are shown in Table XIV.

TABLE XIV
Apportionment of Costs

	3-1/4%	7-5/8%
Plan A		
Federal Investment		
Corps of Engineers		
Project Construction		
61% x $5,648,000	$3,445,280	$ 0
62% x $5,648,000	0	3,501,760
U.S. Coast Guard		
Navigation Aids	6,000	6,000
TOTAL FEDERAL INVESTMENT	$3,451,280	$3,507,760
Non-Federal Investment		
Cash Contributed for Project Constr.		
39% x $5,648,000	2,202,720	0
38% x $5,648,000	0	2,146,200
TOTAL NON-FEDERAL INVESTMENT	$2,202,720	$2,146,200
TOTAL PROJECT INVESTMENT	$5,654,000	$5,654,000

TABLE XIV (Cont.)
Apportionment of Costs

	3-1/4%	7-5/8%
Plan B		
Federal Investment		
Corps of Engineers		
Project Construction		
65% x $5,831,000	$3,790,150	$ 0
66% x $5,831,000	0	3,848,460
U.S. Coast Guard		
Navigation Aids	6,500	6,500
TOTAL FEDERAL INVESTMENT	$3,796,650	$3,854,960
Non-Federal Investment		
Cash Contributed for Project Constr.		
35% x $5,831,000	2,040,850	0
34% x $5,831,000	0	1,982,546
TOTAL NON-FEDERAL INVESTMENT	$2,040,850	$1,982,542
TOTAL PROJECT INVESTMENT	$5,837,500	$5,837,500
Plan C		
Federal Investment		
Corps of Engineers		
Project Construction		
62% x $7,911,000	$4,904,820	$ 0
64% x $7,911,000	0	5,013,000
U.S. Coast Guard		
Navigation Aids	9,500	9,500
TOTAL FEDERAL INVESTMENT	$4,914,320	$5,072,500
Non-Federal Investment		
Cash Contributed for Project Constr.		
38% x $7,911,000	3,006,720	0
36% x $7,911,000	0	2,847,960
TOTAL NON-FEDERAL INVESTMENT	$3,006,180	$2,847,960
TOTAL PROJECT INVESTMENT	$7,920,500	$7,920,500

BRISTOL HARBOR

BRISTOL, RHODE ISLAND

PHASE I AE&D

APPENDIX G

SPECIAL STUDIES

PREPARED BY THE
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

APPENDIX G
SPECIAL STUDIES

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DESCRIPTION OF STUDIES

SHELLFISH SURVEY AND COMMENTS

ON THE

PROPOSED NAVIGATION IMPROVEMENT

BRISTOL, R.I.

By: Arthur R. Ganz
Marine Biologist

Marine Experiment Station
Jerusalem, R.I.

March 1979

A quahaug survey of the impact area in Bristol Harbor was conducted on March 21, 1979. Present were: Mr. Gilbert Chase, U.S. Army Corps of Engineers; Mr. Wynn Robinson, U.S. Fish and Wildlife Service; and myself.

The survey consisted of making standard 5-minute tows with a Fall River Rocking Chair Dredge at nine sites within the area (locations enclosed).

Bay quahaugs (Mercenaria mercenaria) was the most abundant commercially valuable benthic organisms sampled. Two channeled whelks (Busycon canalculatum)and twelve mussels (Mytilus edulis) were sampled. Quarter deckers (Crepidula fornicata) was the most abundant fouling organism.

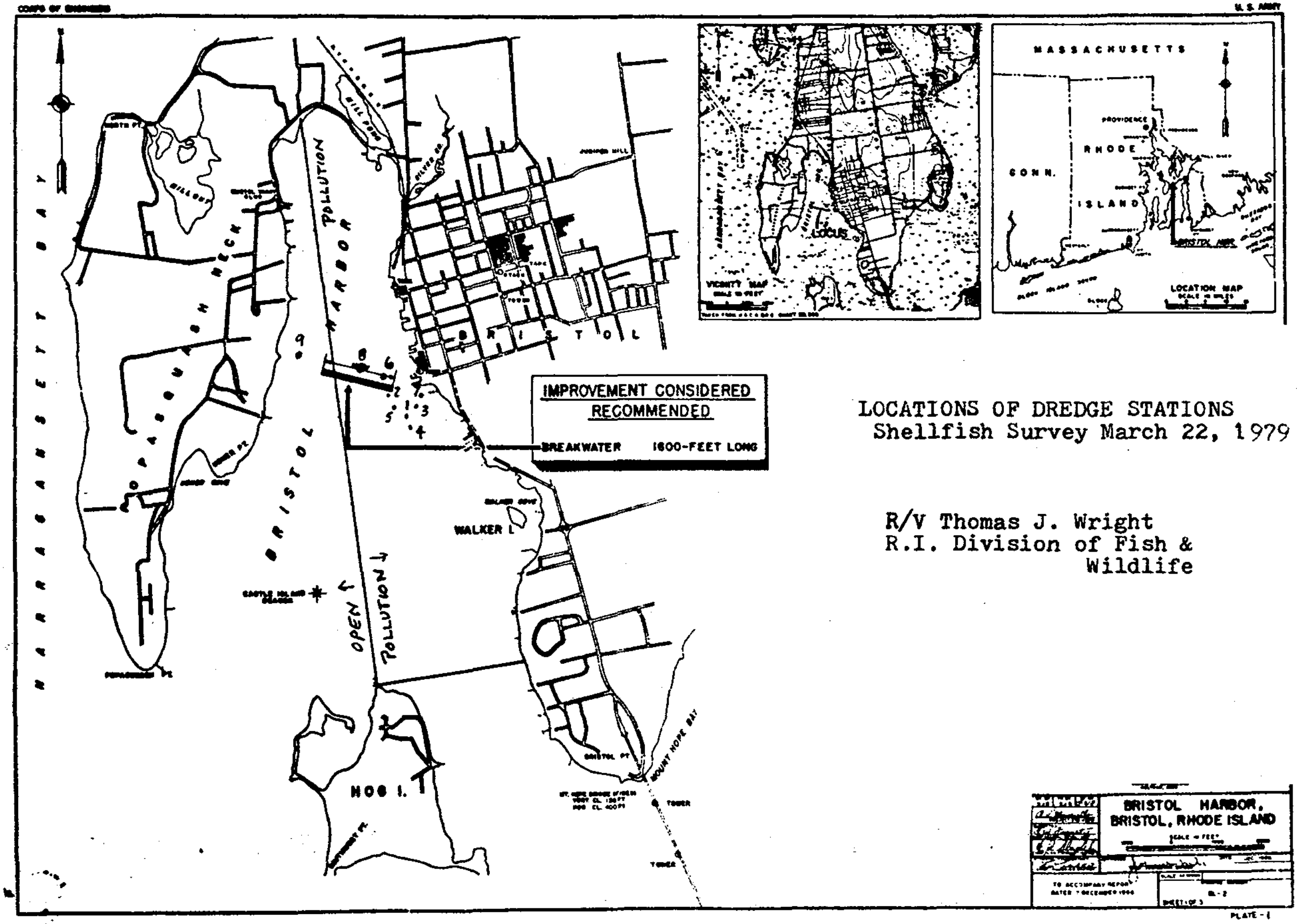
SUMMARY OF QUAHAUG ABUNDANCE PER TOW

Station	Depth(ft)	Chowders*	Littlenecks*
1	17-18	4bu	0.25bu
2	20-25	3 3/4bu	0.25bu
3	25	1bu	18ea
4	22	1.5bu	23ea
5	22	3.25bu	1/4bu
6	22	14ea	14ea
7	18-20	6ea	0
8	22	9ea	0
9	15-18	1bu	20ea

*Where:undersized are less than 1.5" littlenecks>"2.25"
chowders<2.75

Stations 6 and 8 are located in the actual breakwater site. Both sites did not contain a significant number of organisms. The other stations south of the breakwater site do contain many quahaugs. It should be noted that this abundance is expected since this resource is within the polluted area and is not harvestable.

Should the project be undertaken this quahaug population would be destroyed during the construction. These organisms would be expected to recolonize the area following construction. It could also be possible to coordinate a state operated quahaug transplant (transfer) from the impact area to a shellfish management area prior to construction. Addition of the breakwater would definitely add habitat for mussel production.



LOCATIONS OF DREDGE STATIONS
Shellfish Survey March 22, 1979

R/V Thomas J. Wright
R.I. Division of Fish &
Wildlife

OTHER FISHERY CONSIDERATIONS

1. Finfish Species: Mobile finfish species would be expected to evacuate the construction site but should return following stabilization. The breakwater would add habitat for tautog (*Tautoga onitis*), and conceivably encourage schooling menhaden (*Brovoortia tyrannus*) and their predators (Striped bass *Morone soxatitis*, and bluefish *Pomatomus saltatrix*).

2. Commercial fishing activities:

Bay quahaugs: Most of the proposed breakwater will be within the polluted area where no harvesting would be done. Northwest of the site, is a state management area where quahaug transplanting is done annually. This area would be impacted, however, this area could be relocated.

There is no record of how many licensed shellfishermen are located in Bristol. Two major shellfish buyers are located in Bristol and good approximations can be made by interviews at these markets.

Lobster: Division of Fish and Wildlife records show that 13 licensed lobstermen are registered from Bristol, however, many more utilize Bristol as a place to sell their catch.

Ocean quahaug (*Arctic islandica*) Four Bristol registered dredge boats (50-70ft) work from the Port of Point Judith. There is no indication that these vessels would relocate if harbor improvements were made in Bristol.

HYDRODYNAMIC AND DISPERSION PREDICTION MODEL OF ENVIRONMENTAL IMPACTS OF BREAKWATER CONSTRUCTION ON BRISTOL HARBOR, RHODE ISLAND

VOLUME I

Prepared for

U. S. ARMY CORPS OF ENGINEERS
Waltham, Massachusetts

Contract No. DACW 33-78-C-0362
Gibb Chase, Contract Manager

Prepared by

NORMANDEAU ASSOCIATES, INC.
Bedford, New Hampshire

July 1980

NOTE

The following pages are only a part of the overall Normandeau Report and are inclosed in this Bristol Harbor Report as a representation of the work performed. The complete report is on file with the Corps of Engineers, New England Division.

Alternative plan letters D_1 and D_2 were changed to B & C in the Phase I GDM Report.

ABSTRACT

The hydrodynamics and dispersion characteristics of Bristol Harbor, RI were studied using the depth-averaged finite-element models CAFE (Connor and Wang, 1974) and DISPER (Liemkuhlr *et al.*, 1975). Modeling techniques, critical assumptions within the models and their previous applications are highlighted. For this study, the circulation was simulated for mean and spring tidal conditions (amplitudes of 0.61 m and 0.76 m, respectively) for each of four cases: no breakwater and Plans A, D_1 and D_2. A comparison of existing tidal conditions with the breakwater effects shows a cyclic formation of several eddy-like circulation cells near the breakwaters in the upper harbor. Lower harbor circulation is unaffected by the structures. There is no difference in circulation patterns between mean and spring tidal conditions. The CAFE current results were utilized as the advective driving force in the DISPER model. The same conditions were used for both models. Three different source locations are utilized within the model: Walker Cove sewage treatment plant outfall, Bristol industrial area adjacent to the Town Pier, and the Bristol Yacht Club. Results from the models confirm our intuitive understanding of the effects of breakwaters on circulation and dispersion: the more restricted the areas of flow are, the more these patterns deviate from the existing patterns. Several analytical techniques are highlighted concerning wind-induced circulation. Winter winds should enhance harbor flushing. Summer winds, although retarding flushing, are weaker and should not dominate circulation. Strong wind events should significantly disrupt the basic patterns, but the effects are only temporary. The effect of a culvert through the short breakwater of Plan D_2 is analyzed with Manning's formula using the tidal height differential across the breakwater as the driving force. Results from the CAFE model indicate that this may not be a reliable source since the differentials do not appear cyclic with respect to the tide. Comparing the magnitude of the culvert flow rate with the inter-breakwater (main channel) rates indicate the former are two-to-three orders smaller than the latter. To eliminate entrapment, detachment is recommended rather than including the culvert. Plan D_1 is recommended on the basis of good flushing and adequate protection from wind waves generated along a southwest fetch. Plan D_2 should be considered only if there has previously been wave damage to the yacht club. The trade off for increased protection is restricted flushing which may have an effect on the biota. Plan A is not considered due to a question of adequate protection from wind waves.

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HYDRODYNAMIC AND DISPERSION PREDICTION MODEL OF ENVIRONMENTAL IMPACTS OF BREAKWATER CONSTRUCTION ON BRISTOL HARBOR, RHODE ISLAND

1.0 INTRODUCTION

The proposed navigational improvement project for Bristol Harbor, Rhode Island, is authorized under the River and Harbor Act of 13 August 1968. Three alternative plans are proposed for rock breakwater construction in Bristol Harbor, located on the upper reaches of eastern Narragansett Bay. In order to investigate the effects of each plan on the circulation and the flushing of the harbor, numerical models are used to simulate this behavior. From these results, the topics of culvert flows through the breakwater and the influence of wind stress on circulation patterns can also be addressed. Finally, from the total set of results, a series of conclusions and recommendations can be made concerning the effect of each breakwater design on the harbor.

The primary construction plan, Plan A (Figure 1) consists of a 1600-ft (488 m) rock breakwater across the entrance to Bristol Harbor with a 400-ft (122 m) wide entrance on the west passage and a 1300-ft (396 m) wide entrance on the east passage. The second alternative, Plan D_1 (Figure 2) a 1700-ft (518 m) dog-leg breakwater separated from the Coast Guard Pier by 100 feet (30 m), and a west passage entrance of 1700 feet (518 m). The third alternative, Plan D_2 (Figure 3), is the same as D_1 with the addition of a 700-foot (213 m) breakwater attached to the western shore which leaves a harbor entrance of 1000 feet (305 m). There are provisions for installing a 6-foot by 6-foot (1.8 m by 1.8 m) gated-culvert in the short, western breakwater in Plan D_2. (The original alternatives, Plans B and C had the dog-leg breakwaters attached to the Coast Guard Pier, also with provisions for a gated-culvert).

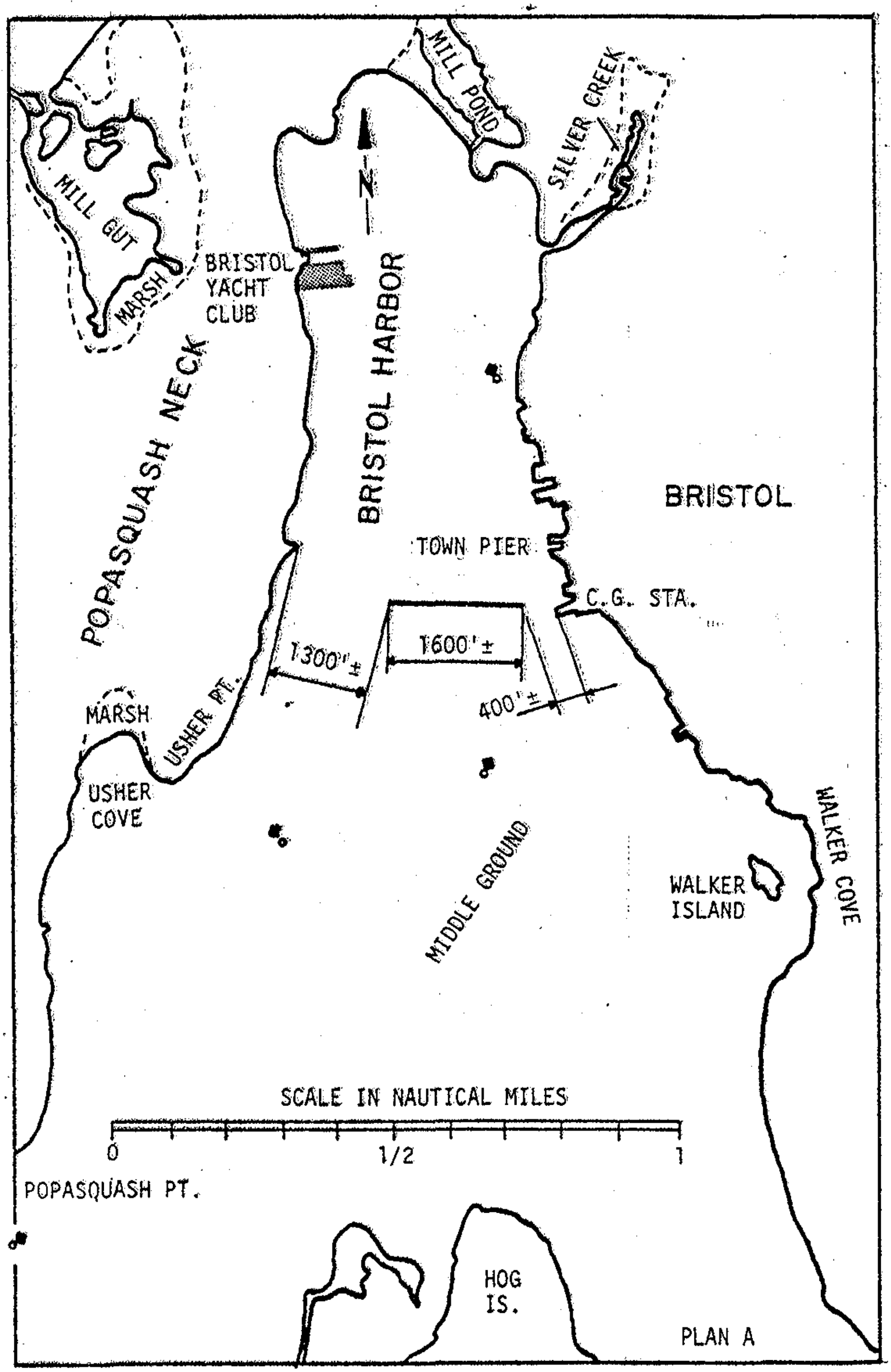


Figure 1. Plan A: Proposed offshore breakwater. Bristol Harbor, Rhode Island.

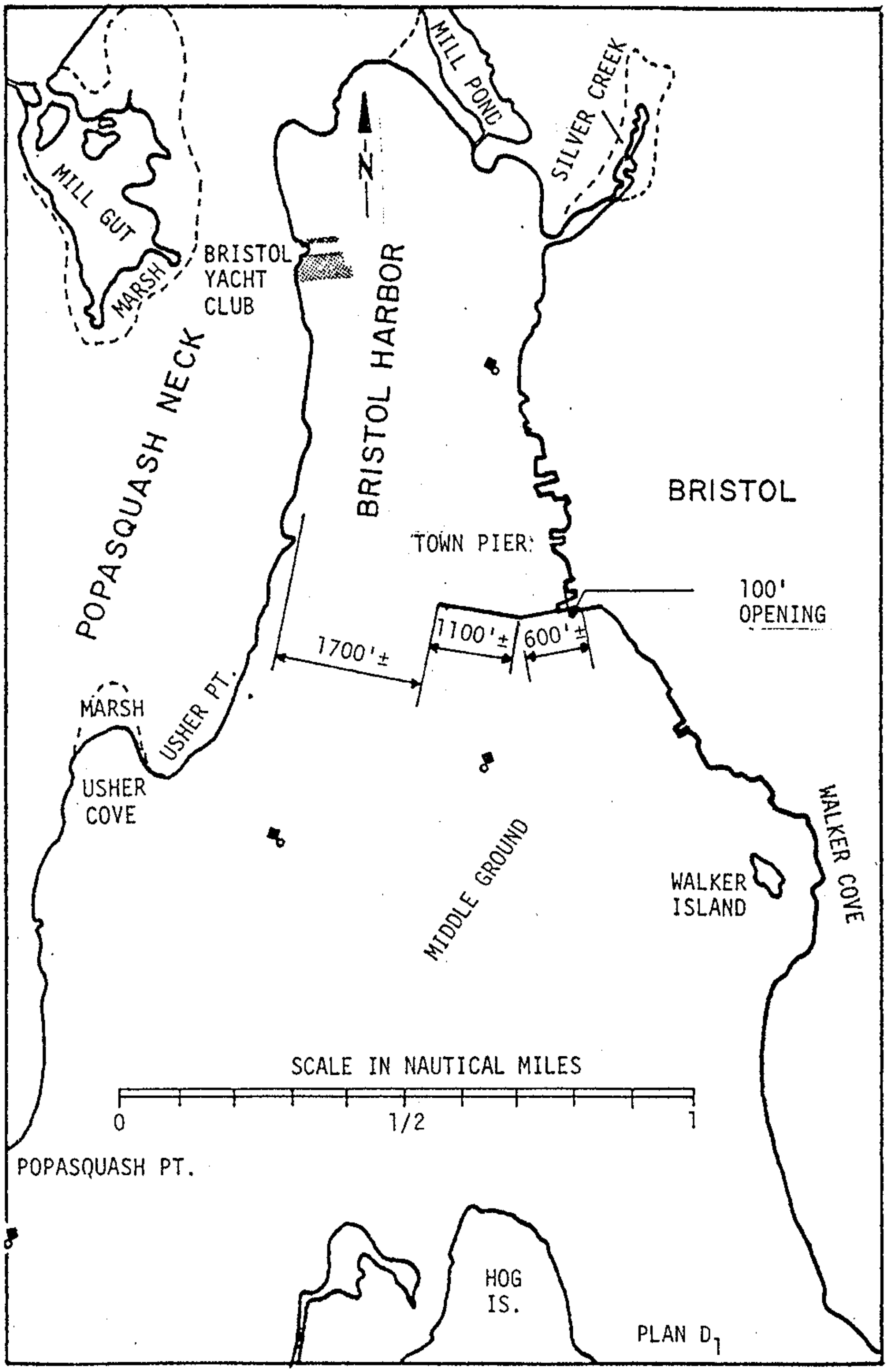


Figure 2. Plan D_1: Proposed offshore breakwater. Bristol Harbor, Rhode Island.

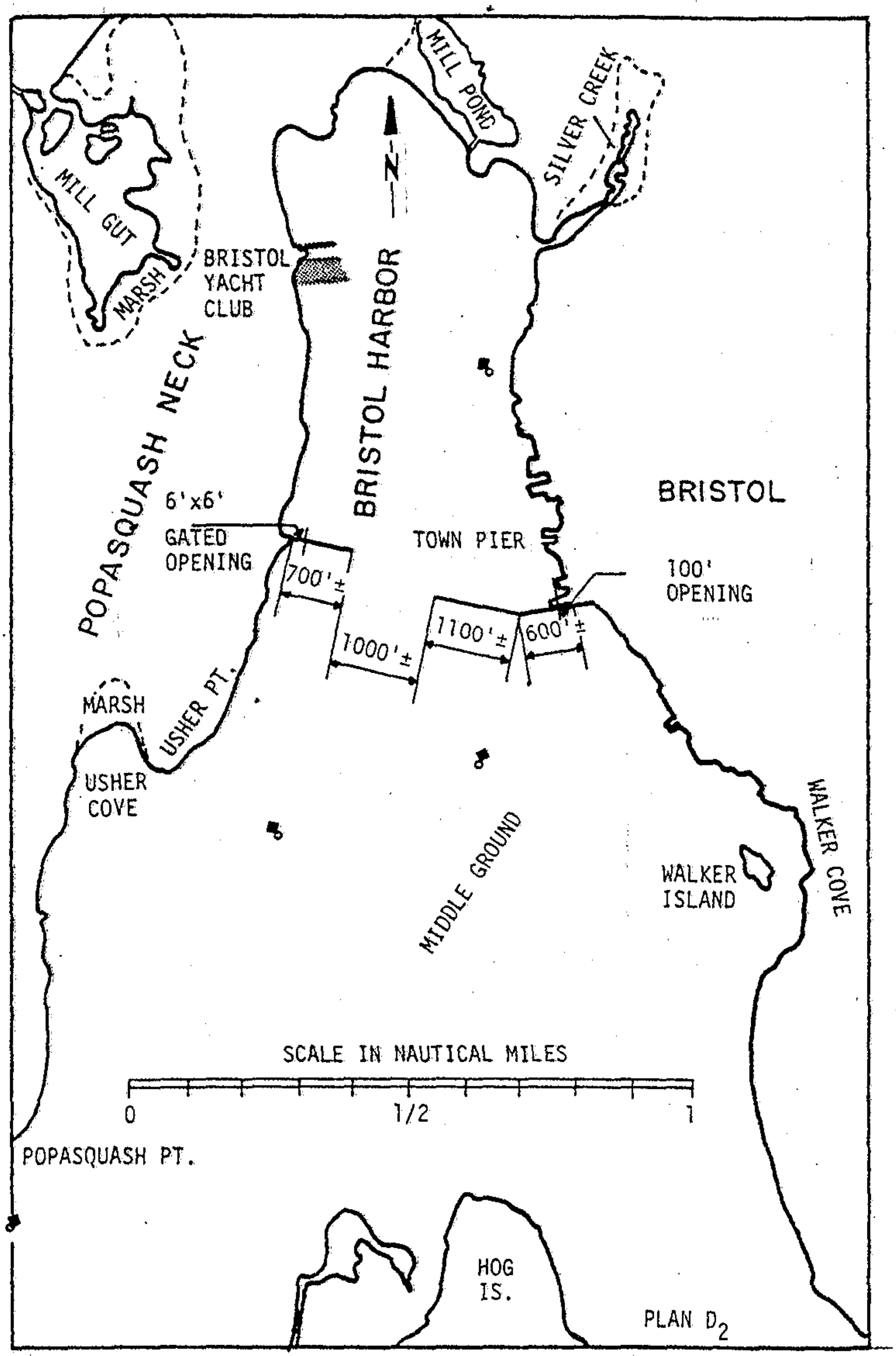


Figure 3. Plan D_2: Proposed rock breakwater. Bristol Harbor, Rhode Island.

In order to understand the present conditions existing in Bristol Harbor with respect to tidal circulation, a two-dimensional numerical, hydrodynamic model is applied to the study area for mean and spring tidal ranges. These circulation results are subsequently used as input for a two-dimensional numerical, dispersion model for the purpose of simulating pollutant dispersion and flushing. Once the existing conditions of flow and transport are known, the effects of each breakwater plan on circulation and dispersion can be measured by comparison. The primary concern of this modeling effort focuses on the prediction of the impact each breakwater will have on harbor flushing.

From the results of these numerical models two other topics can be addressed using analytical procedures. The first analysis concerns the effects of wind stress on the predicted tidal circulation and flushing in Bristol Harbor with and without breakwaters. The second analysis concerns the effect of installing a 6-foot by 6-foot culvert within the 700-foot western breakwater of Plan D_2. From the previous numerical and subsequent analytical results recommendations are made for the various breakwater configurations.

1.1 PROJECT SUMMARY

General Scope - Development of a Hydrodynamic and Dispersion Numerical Model for the analysis of tidal currents, flushing patterns, culvert flows, wind influences and tidal circulation patterns within Bristol Harbor with and without the construction of the proposed three alternative rock breakwaters.

Work Element I. HYDRODYNAMIC AND DISPERSION MODELING IN BRISTOL HARBOR, RI

Task 1 - Application of a two-dimensional numerical, hydrodynamic model to determine normal tidal circulation and elevation patterns under present conditions (Mean and Spring Tide Ranges).

Task 2 - Case studies using the computer model to predict the impact of three (3) proposed breakwater plans on circulation within the harbor and to optimize the length, orientation, and configuration of the breakwater(s) with respect to flushing action.

Task 3 - Case study using the computer model to predict the dispersion and flushing of pollutants to accompany each of the three proposed structures and compare with conditions forecasted to exist in their absence.

Task 4 - Specific analysis will be performed using the computer model to predict the effects of winds on the tidal dynamics within the harbor with and without these structures and also with the possible construction of culverts (6' x 6' gated opening) built into the breakwater(s).

Task 5 - Report - discussion of methodology and findings including graphics, conclusions and recommendations.

2.0 STUDY AREA

Bristol Harbor is located in Bristol, Rhode Island between Popasquash and Bristol Necks on the upper portion of Narragansett Bay. This harbor with a surface area of 10.8 square miles (28 km^2) has no appreciable source of fresh water inflow. However, two small bodies of water, Mill Pond and Silver Creek, are located at the northern end of the harbor.

Bristol Harbor connects with Narragansett Bay by two passages, one on each side of Hog Island. Tides in the Bay as well as the harbor are dominted by the M_2 or lunar, semi-diurnal tidal component. The harbor is a small embayment which behaves within the context of the larger, overall behavior of Narragansett Bay.

The town of Bristol, located 16 miles (25.7 km) southeast of Providence, dominates the eastern shore of the harbor. This small but growing community had a population density of 1751 per square mile (676/km^2) as of 1970 within an area of 10.2 square miles (26.4 km^2). This community with its rich and colorful history dates back to 1681, and has always had a maritime tradition which included ship-building between the Civil War and post-World War II. Like many other coastal New England towns, Bristol's economy changed from an agriculture basis to manufacturing during the course of the Industrial Revolution and remains so today.

The town of Bristol generates harbor pollutants from three main sources. About 2.5 million gallons per day (110 liters/second) of treated effluent are discharged into the lower harbor west of Walker Island from the local primary sewage treatment plant. Manufacturing and docking facilities occupy about an 800 yard (732 meter) stretch of shore along the upper harbor and constitute a second source of pollution. Lacking any specific data from this area, the figures are generally considered to be of the order of one-tenth that of the sewage treatment effluent. A third source of pollution in the harbor is expected to be the Bristol Yacht Club. Again, for lack of data this source is generally considered to be of the order of one-hundreth that of the sewage treatment discharge. The fact that the dispersion characteristics of the harbor will be altered by the breakwater construction, especially when considering these pollution discharge points, is the primary concern of this investigation.

Very little actual hydrographic data exists for Bristol Harbor. The National Ocean Survey (NOS) has produced tables for tidal currents (NOS, 1980a) and tidal heights (1980b) in or near the study area. Currents at the Mount Hope Bridge which connects Bristol Point to Aquidneck Island average 1.1 knots (0.6 m/s) at 47° True at maximum flood and 1.4 knots (0.7 m/s) at 230° True at maximum ebb. The minimum before both flood and ebb is zero indicating the currents here are bidirectional. The range of the mean and spring tides at Bristol Point, where the Mount Hope Bridge connects to Bristol Neck, is 4.0 feet (1.2 m) and 5.0 ft (1.5 m) respectively. At the town of Bristol, the mean and spring tide ranges are 4.1 feet (1.2 m) and 5.1 feet (1.6 m) respectively.

3.0 MODELS

3.1 HYDRODYNAMIC MODEL

A hydrodynamic numerical model is used to predict the tidal height and current vectors within the marine environment. The body of water is approximated by an appropriate gridwork of points. By specifying the initial and boundary conditions of the problem, a series of results are simulated. Breakwaters are handled as simply changes in the boundary conditions. Usually a hydrographic data set is required to calibrate and verify the model simulation.

The basis of the hydrodynamic, numerical model are the Eulerian equations of motion for a viscous Newtonian flow, or the Navier-Stokes equations consisting of the momentum equations in three dimensions and the ensemble-averaged continuity equation (Neumann and Pierson, 1966). A general, analytical solution does not exist for the hydrodynamic equations due to the closure problem, that is, there are more variables to solve for than equations. A number of simplifying assumptions must be made to achieve closure which renders the equations of motions solvable by particular techniques. The equations are initially simplified by assuming incompressible fluid flow, constant density, constant eddy viscosity and that the second derivative of each velocity component with respect to perpendicular coordinates is small enough to be considered negligible. Applying a Reynolds decomposition, which represents each variable as the sum of its ensemble average and a fluctuation about that average, to the equations of motion produces an averaged set of equations whose stochastic processes are smoothed or filtered while retaining deterministic processes (Schlichting, 1968). However, this process produces several extra terms which are the components of the Reynolds stress tensor (the product of the density and the ensemble average of the product of the component velocity fluctuations about their means). These terms are simplified in a subsequent step. Without a loss of meaning, the three-dimensional equations of motion can be reduced to a set of two-dimensional equations by integrating over the total depth assuming vertical variations of variables are negligibly small and by applying Leibnitz's rule (Connor and Wang, 1974). The vertical momentum equation simply reduces to the hydrostatic balance relation as expected. The sum of the Reynolds stress and the internal stress forms the total stress. The Boussinesq approximation replaces the momentum flux terms resulting from the vertical integration of total stress components with velocity gradient terms whose constants of proportionality are the kinematic eddy viscosity coefficients (Neumann and Pierson, 1966). Bottom shear stress is approximated by a quadratic function of depth-integrated fluid velocity whose proportionality constant is a dimensionless friction factor. Similarly surface shear stress, if present, is approximated by a quadratic function of the wind velocity (usually measured at 10-meters) whose proportionality constant is a different dimensionless friction factor. (For simplicity these friction factors are considered constants, but several function relationships with respective velocities have been presented in the literature). The result is a two-dimensional momentum balance. The temporal and convection acceleration terms are balanced primarily by the surface slope and bottom friction terms and secondarily by the Coriolis and eddy viscosity terms. Thus the driving force of the surface slope is primarily resisted by bottom friction with the remaining energy producing the velocity vector field.

The problem is completed by specifying the boundary conditions which is the value of a flow component or of the surface elevation along a boundary. Normal flow on land boundaries are zero, and along river boundaries, if present, are equal to the river flow rates. Along open ocean boundaries, the values of the surface elevation are specified. The system of equations, while still too complex for analytical techniques to solve, can be solved using one of several numerical techniques. (Analytical methods arrive at exact solutions to specific problems. When an analytic solution does not exist, or is overly complex, then solutions can be approximated using numerical methods).

A variety of numerical methods exist to solve partial differential equations (Ames, 1977) of which the two-dimensional, vertically-averaged, hydrodynamic equations are an important subset (Roache, 1976).

Two general techniques are used to obtain solutions: finite-differences and finite-elements. The finite difference (FD) method, the simpler of the two, has two different types of techniques for the advancement of the equations in time: explicit and implicit. Explicit-time FD-equations are advanced through time for each time-step using previous values. Implicit-time FD-equations, step through time by solving systems of simultaneous equations, which is a time-consuming process since each step requires a matrix inversion or an equivalent technique. The finite-element (FE) method approximates a solution by optimizing a precise linear interpolating function which also requires a series of matrix inversions or equivalent since it is also an implicit method. Each method has its particular advantages and drawbacks (Thacker, 1978a,b).

In comparing the methods, let us first consider the stability criterion. The Courant number γ represents a dimensionless measure of the time step as

$$\gamma = c\ \Delta t/\Delta x$$

where c is the celerity or wave velocity ($c = \sqrt{gD}$, where g is the acceleration due to gravity equal to 9.81 m/sec^2 or 32.2 ft/sec^2 and D is the total water depth), Δt the time increment and Δx the grid spacing. Implicit-time FD methods are unconditionally stable, at least for incompressible flows, whereas the stability criterion for the explicit-time FD-methods is given by $\gamma \leq 1$ (Roache, 1976). The FE-method has the stability criterion of $\gamma \leq 1/\sqrt{2} \approx 0.707$ (Connor and Wang, 1974). Thus the stability criterion requires the FE-method take 30% more time than the time-explicit FD-method which affects the computational economy of this method.

FD-methods have the advantage of being easily understood and applied especially in the case of an explicit-time step. Irregular grids for FD-equations are possible but tend to make the application more difficult. FE-methods were specifically devised for irregular grids which makes them very attractive in coastal modeling applications. For this reason, we use the two-dimensional FE-solution technique of

Connor and Wang (1974) presented in Circulation Analysis by Finite Elements or CAFE model (Celikkol and Reichard, 1976). Let us examine this method more closely.

The finite element method approximates the solution of a boundary value problem with a function of piece-wise continuous polynomials. This involves discretization of the continuum into an equivalent system of finite elements. Connor and Wang selected the simplest configuration, triangles with nodes at the vertices. The values of the variables within the element are assumed to be a linear function of the values at the nodes. The equations are transformed for application to an element using this linear polynominal representation. Treatment of the entire continuum is accomplished through summation of the contributions of each element. Each nodal value influences all of the elements containing that node, and each element value influences the three nodes of the element. Depth is selected at each node point, while bottom friction and eddy viscosity are selected for each element.

3.2 DISPERSION MODEL

A dispersion numerical model is used to predict the concentrations of material within a fluid body. This material is transported by three processes: advection by currents, turbulent diffusion by eddies and molecular diffusions by Brownian motion (which is essentially small enough to ignore when compared to the first two processes). Thus the solution of the dispersion model depends on results from the hydrodynamic model to calculate advection.

The basis of the dispersion, numerical model is the Eulerian equation for the conservation of mass of the dispersant (Sayre, 1975). A number of simplifying assumptions are necessary to achieve closure. By assuming an incompressible flow as in the hydrodynamic model case, this relationship reduces to the Eulerian diffusion equation in a convective flow field. By applying a Reynolds decomposition to this diffusion equation, additional terms (the negative of the ensemble average of the product of the component velocity fluctuations and the concentration fluctuation about the mean) are produced analogous to the components of the Reynolds stress tensor (Sayre, 1975). Again, without a loss of meaning, the resultant equation is integrated over depth (Liemkuhler *et al.*, 1975). The Boussinesq approximation replaces the mass flux terms resulting the vertical integration of diffusion components with mean concentration gradient terms whose constants of proportionality are the turbulent diffusion coefficients. The molecular diffusion coefficients are generally several orders of magnitude smaller than the turbulent diffusion coefficients which can be absorbed by the turbulence parameters or simply ignored as being negligible. The similarity between this development and that for the hydrodynamic equations makes them compatible. Consistency is required since the advection terms in the diffusion equation come from the hydrodynamic equations. The problem is completed by specifying the initial and boundary conditions, the source and sink parameters, decay coefficients for any non-conservative constituents and settling velocities in the case of suspended sediments.

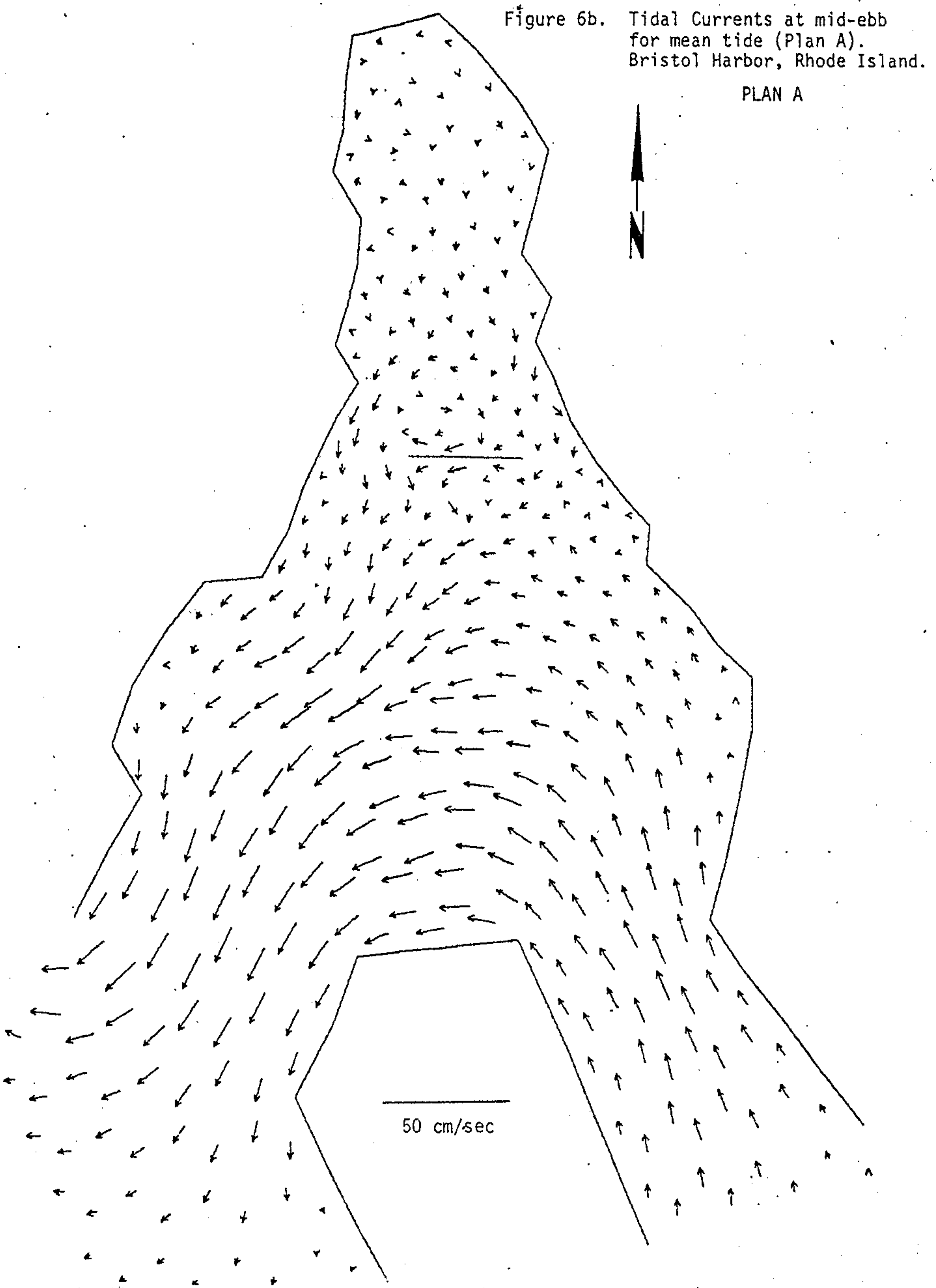
The same numerical methods available for the hydrodynamic equations are applicable to the dispersion equation. For reasons previously stated at the end of Section 3.1, a FE-technique is used. The companion to the CAFE model is the two-dimensional, FE, vertically-integrated dispersion model of Leimkuhler *et al.* (1975) known as DISPER. By properly specifying the various input parameters to the program such as grid spacing, sources, sinks, and the associated coefficients, the model can determine the simulated behavior of constituent concentrations with respect to a simulated flow field.

3.3 PREVIOUS APPLICATIONS

Both the CAFE and DISPER models have been previously applied in several studies. The CAFE model was originally applied to a model of Massachusetts Bay by Connor and Wang (1973). CAFE solutions compare favorably with the analytical solutions for the simple case when analytical solutions can be found by linearizing the equations of motion. CAFE solution for the general case of non-linear equations of motion describe what is intuitatively believed to be the general circulation of the Bay. Sufficient field data did not exist to compare the model with.

The CAFE model has also been applied to the Great Bay Estuarine System (Celikkol and Reichard, 1976), Sakonnet Harbor, Rhode Island (NAI, 1979a), New Haven Harbor, Connecticut (NAI, 1979b), the Piscataqua River, New Hampshire (NAI, 1980) and Portsmouth Harbor, New Hampshire (Parsons *et al.*, 1976). For each study, the model results compared favorably with the field results from current meter surveys when the field conditions approximated the model assumptions (Reichard and Celikkol, 1978; NAI, 1979a, 1979b, 1980; Parsons *et al.*, 1976). The dispersion model DISPER was used in conjunction with the CAFE model for two of these studies. In Portsmouth Harbor, DISPER was utilized to predict the extent of suspended sediment dispersion over varying tidal conditions (Parsons *et al.*, 1976). In the second case, for New Haven Harbor, DISPER predicted the dispersal of sewage effluent by tidal currents (NAI, 1979b). The predicted effluent dispersion patterns compared favorably with a companion dye study when field conditions approximated the model assumptions. In conclusion, both the CAFE and DISPER models have been successfully applied to several different study areas. Their results compare well with either the intuitative understanding of the study area dynamics, the analytical results from the linearized set of equations, or field measurements taken for model validation. Because of these previous successes, we assume these models adequately simulate the behavior of Bristol Harbor within the context of assumptions of the derivations.

Figure 6b. Tidal Currents at mid-ebb for mean tide (Plan A). Bristol Harbor, Rhode Island.



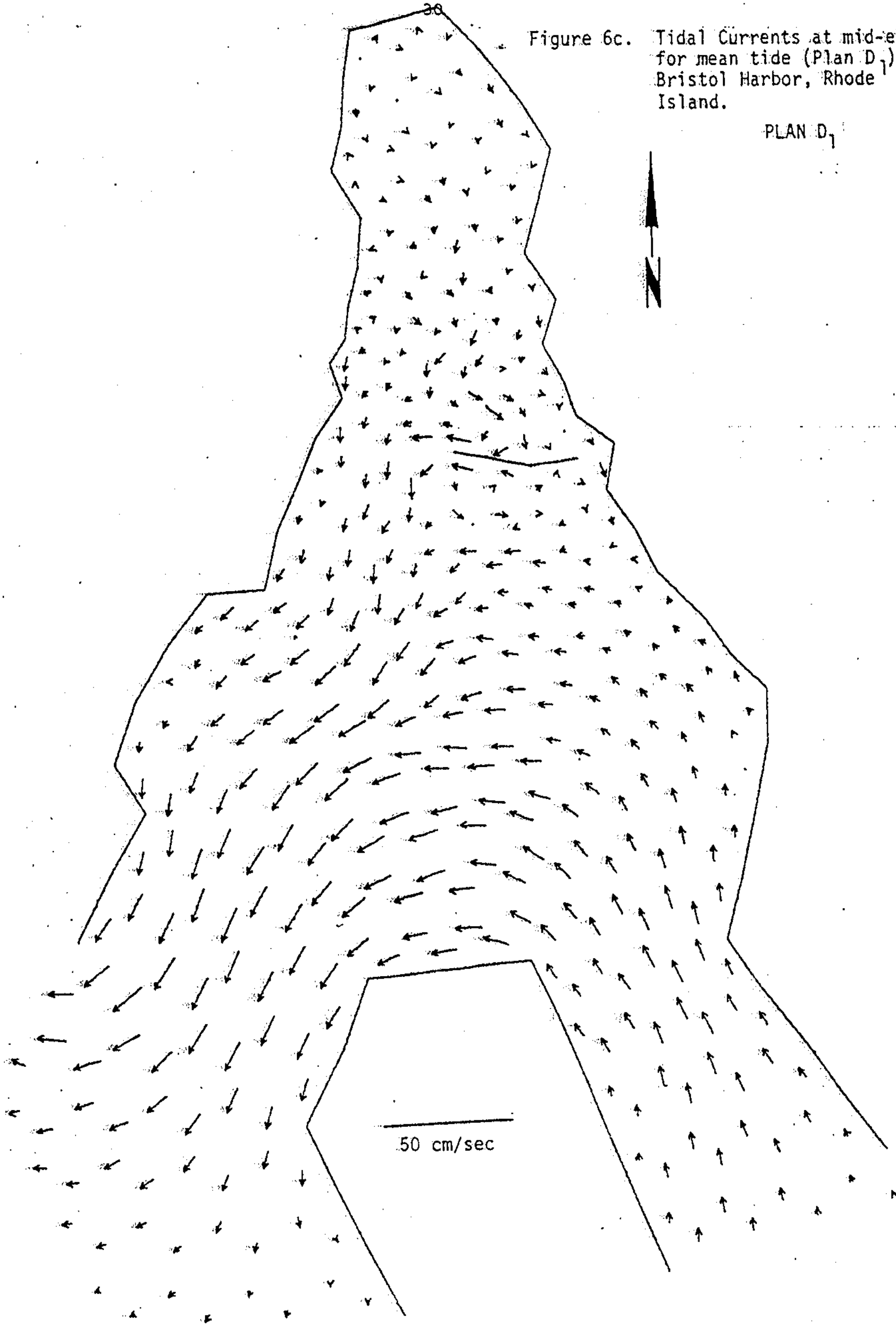


Figure 6c. Tidal Currents at mid-ebb for mean tide (Plan D_1). Bristol Harbor, Rhode Island.

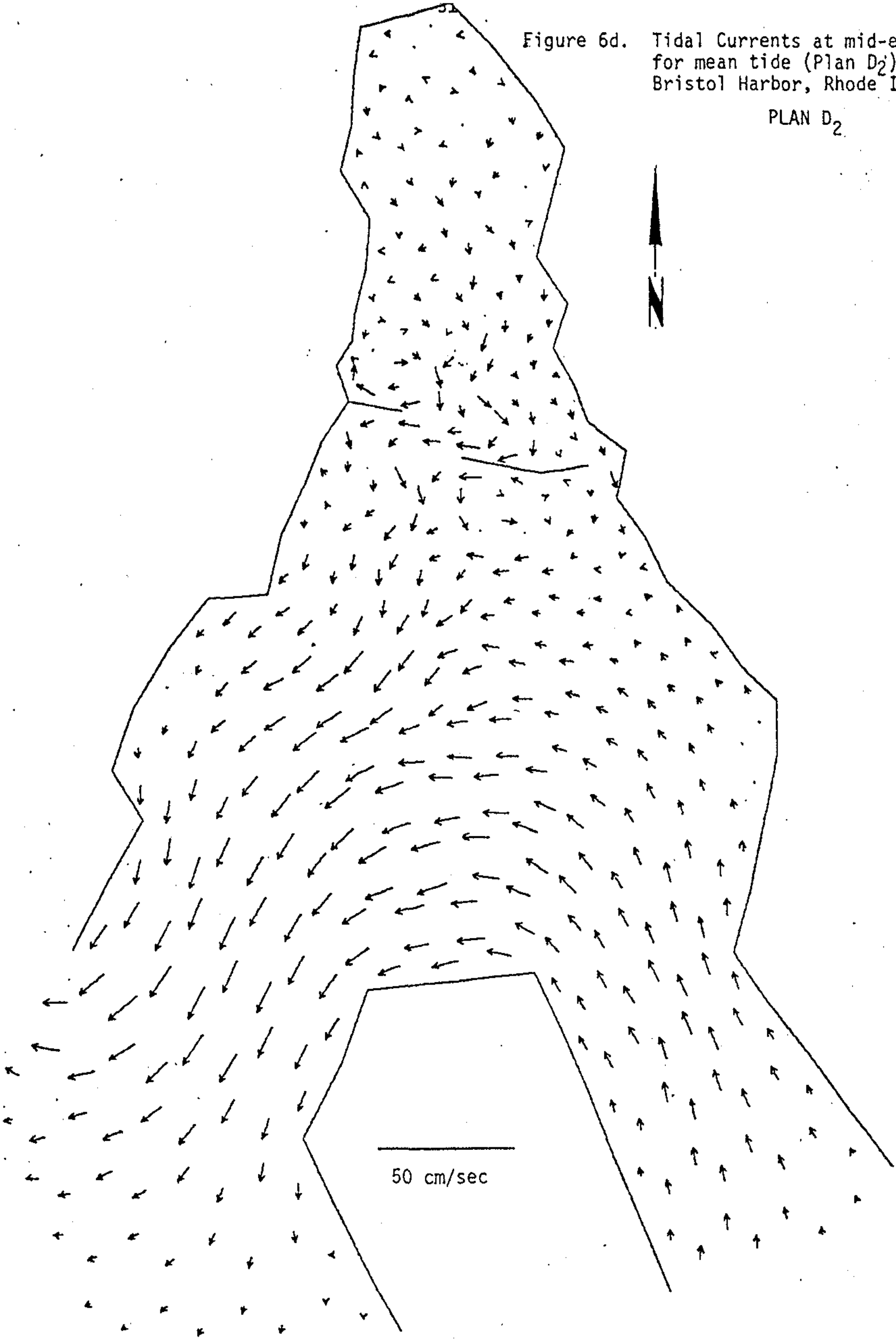
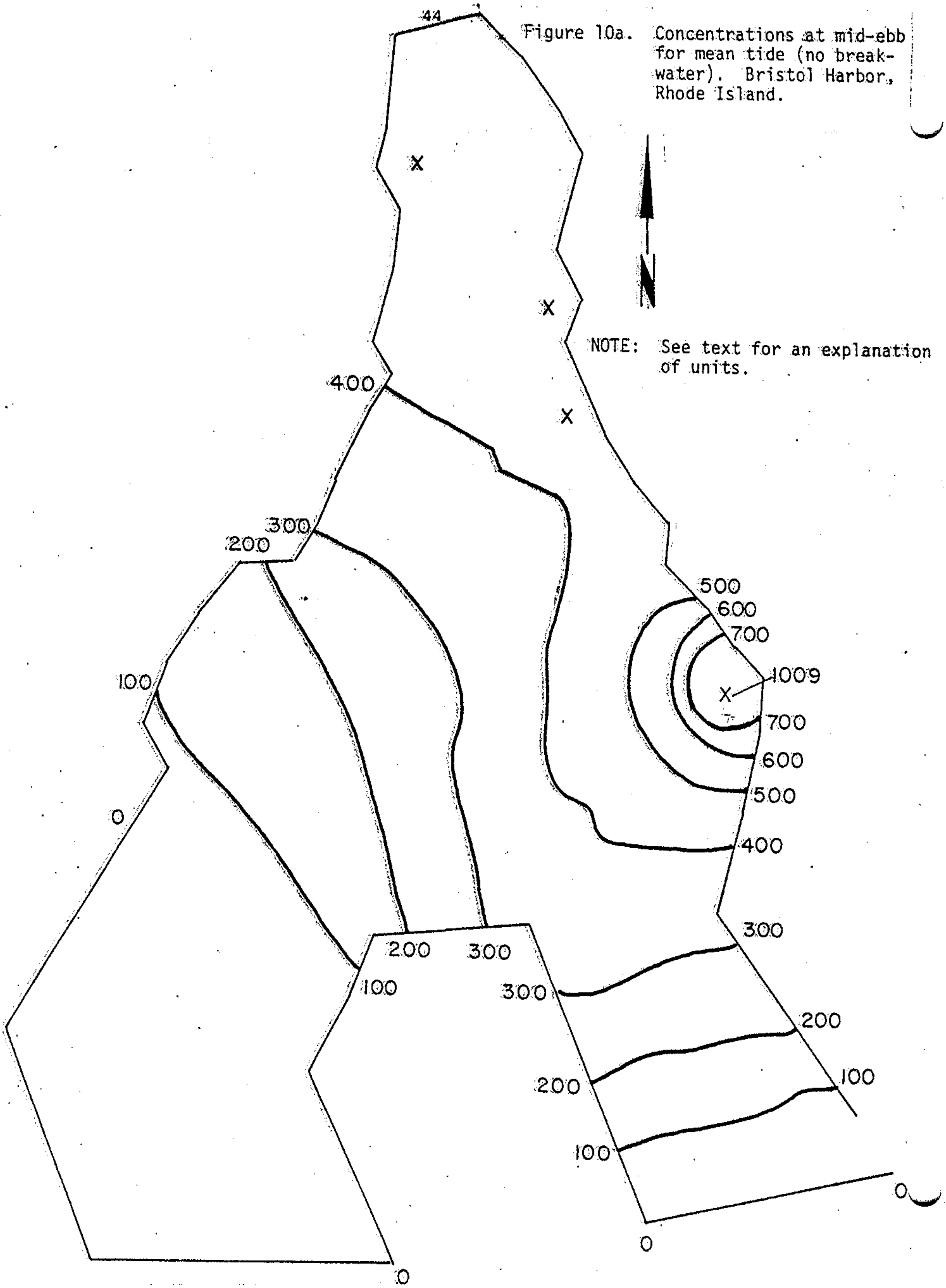


Figure 6d. Tidal Currents at mid-ebb for mean tide (Plan D_2). Bristol Harbor, Rhode Island.

Figure 10a. Concentrations at mid-ebb for mean tide (no breakwater). Bristol Harbor, Rhode Island.



NOTE: See text for an explanation of units.

Figure 10b. Concentrations at mid-ebb for mean tide (Plan A). Bristol Harbor, Rhode Island.

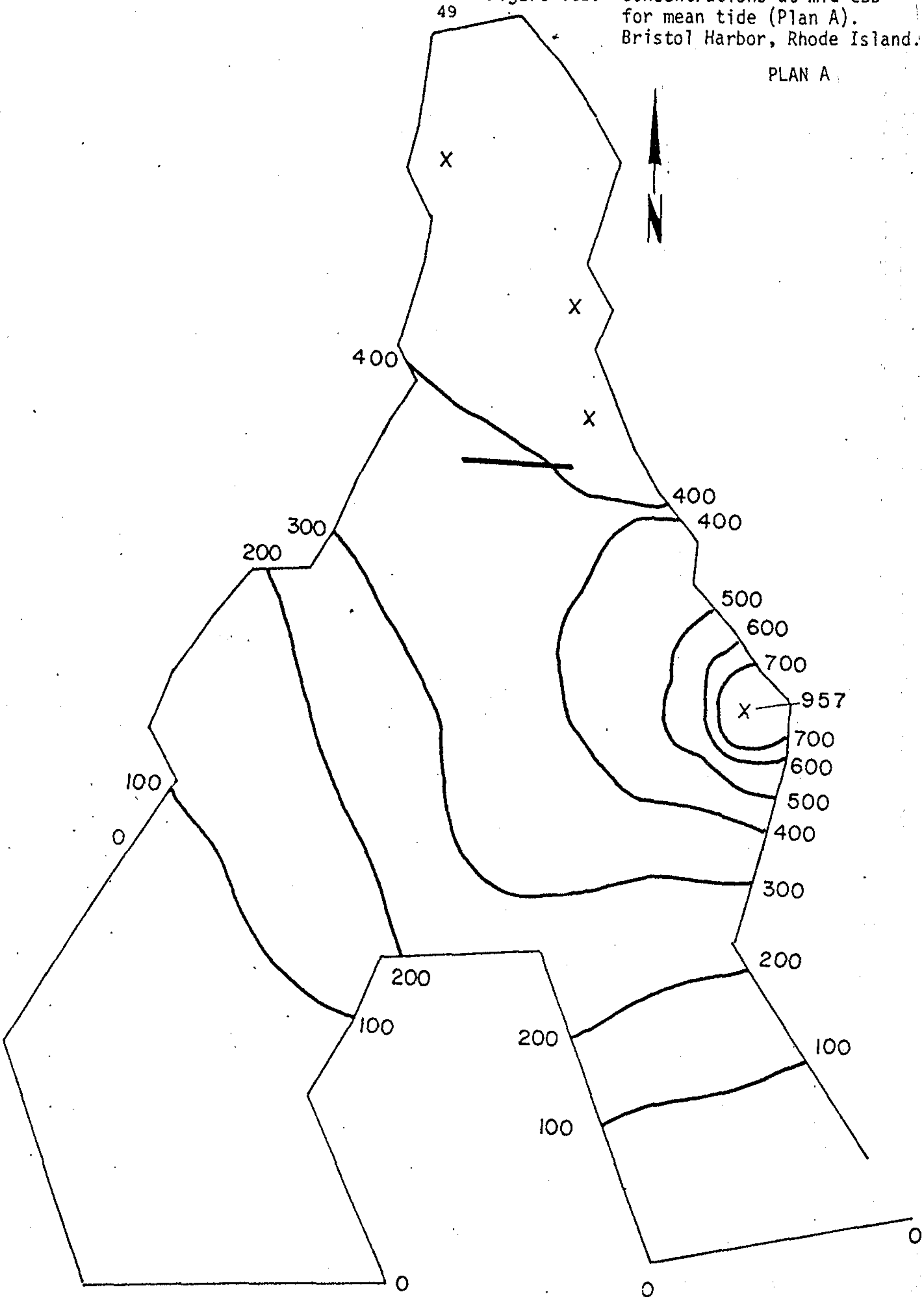


Figure 10c. Concentrations at mid-ebb for mean tide (Plan D_1). Bristol Harbor, Rhode Island.

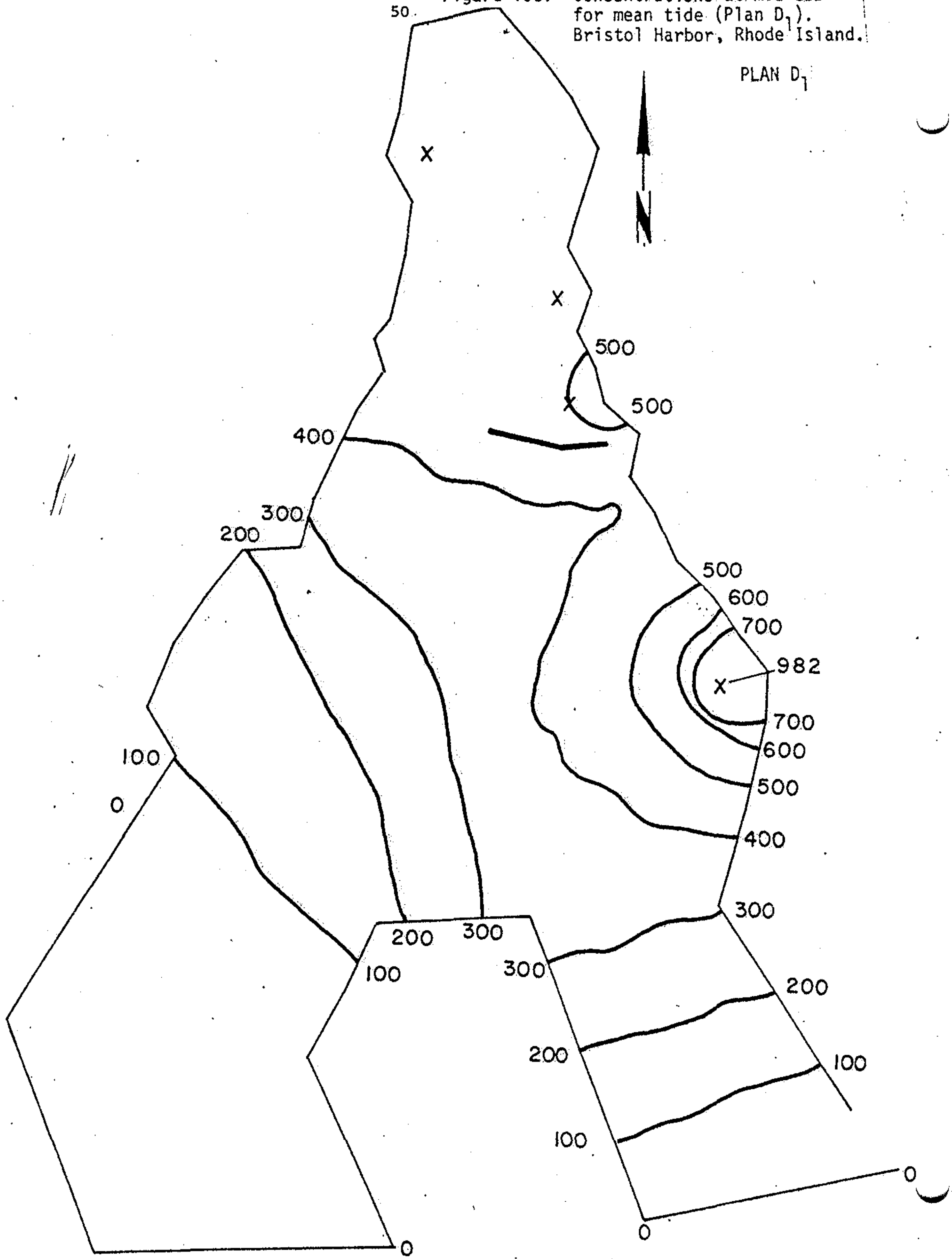
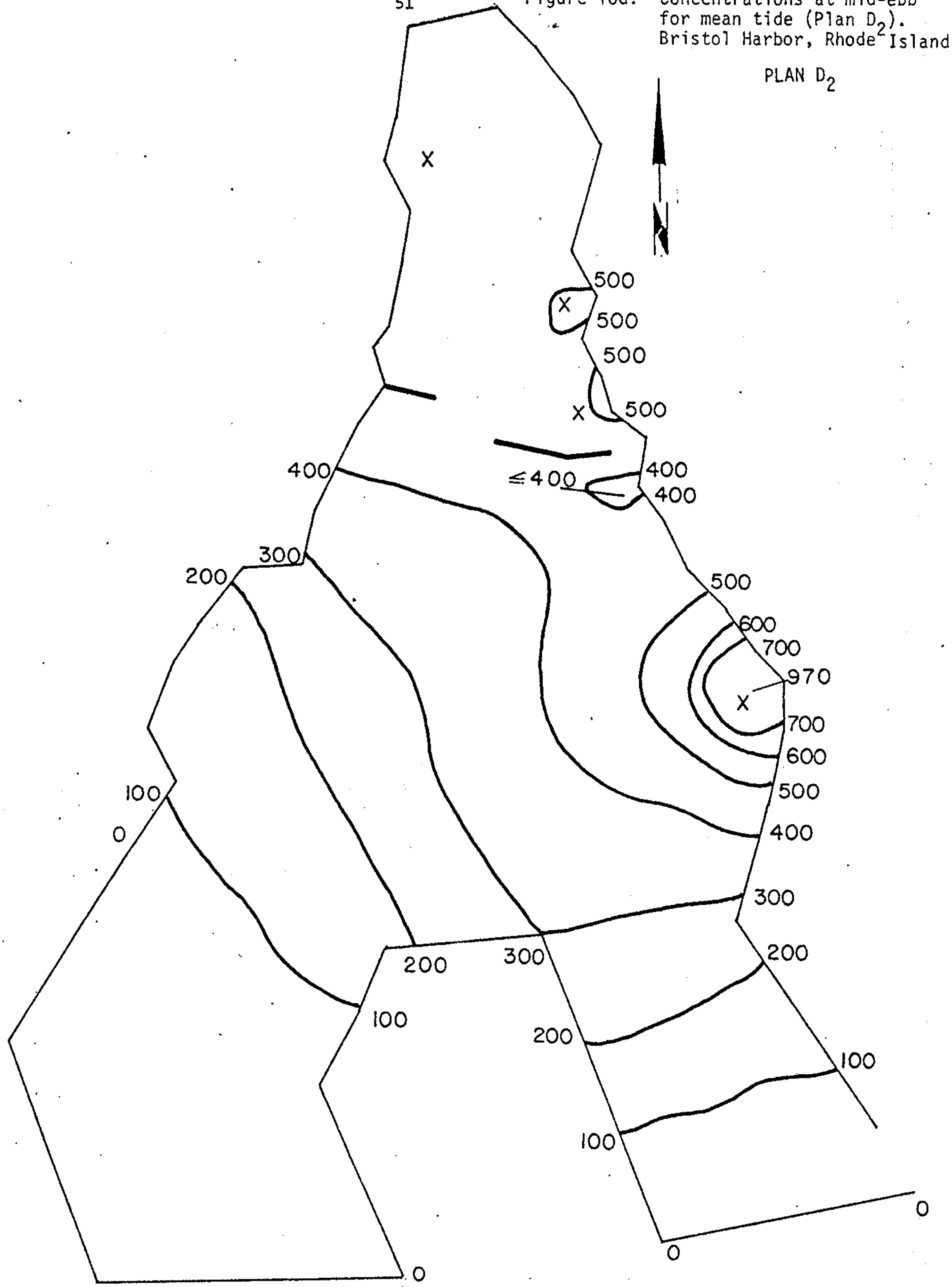


Figure 10d. Concentrations at mid-ebb for mean tide (Plan D_2). Bristol Harbor, Rhode Island.



7.0 CONCLUSIONS AND RECOMMENDATIONS

The application of the CAFE model to Bristol Harbor as it presently exists (i.e. no breakwater) shows a very simple two-dimensional circulation pattern. During the ebb, currents flow counterclockwise around Hog Island in the lower harbor and seaward (south) in the upper harbor. On the flood, these currents reverse. The breakwaters each have the same general effect on upper harbor circulation while not affecting currents in the lower harbor. Eddies are formed north and south of each breakwater; their maximum speeds occur an hour before and after slack water with a relative minimum during slack water. During mid-ebb and mid-flood these eddies disorganize but soon after they reorganize in the reverse direction. Tidal heights are not significantly altered by the breakwater construction with an overall range difference of several centimeters.

Three source areas of pollution have been identified and dispersion within the harbor has been mapped by simulating the conservative mixing of dye released from the source points. Eighty-three percent of the input is assumed to originate from the Walker Cove outfall from the town's primary sewage treatment plant, sixteen percent from the industrial area adjacent to Town Pier and one percent from the yacht club. Concentrations within the upper harbor without a breakwater are maximum at high-slack and minimum at low-slack water. Dispersion patterns for breakwater Plans A and D_1 most resemble the ambient pattern since those plans are the least restrictive with respect to flow. The concentration maps for Plan D_2 indicate a tendency for a higher concentration build-up during certain tidal phases. This means that the flushing for Plan D_2 is not as efficient as the other two. This build-up may also have adverse effects on the biota, especially the benthic organisms.

Without any breakwater, analyses indicate that the upper harbor tends to be dominated by wind-driven circulation rather than tidal circulation. Northwest winds which predominate the winter will increase flushing. Southwest winds characteristic of summer will retard flushing, but, since they are generally weak, they are not a serious problem. The restrictive nature of the breakwaters causes increased current speeds within and around the upper harbor. Although upper harbor circulation with the breakwaters will still be influenced by wind effects, the increased current speeds will help to insure harbor flushing.

Wind waves are expected to be fetch-limited and substantial generation is expected only from a southwest wind. The dog-leg breakwater of Plan D_1 seems adequate to protect the Town Pier area from the waves generated along the area of maximum fetch, whereas the single, straight breakwater of Plan A appears inadequate. Winds from other directions do not have as large a fetch, and wave production should be significantly reduced. In this respect, unless there is a problem with wave damage from south winds at the Bristol Yacht Club, the short western breakwater of Plan D_2 serves no purpose.

Culvert flows through the short eastern breakwater of Plan D_2 have a minimal on the overall flow rate between the upper and lower harbors. Flows did not exhibit a regularity in phase with the tide and this tends to indicate an unreliability in this method of flushing. To reduce the entrapment of material by this breakwater, the breakwater can be detached from the western shore. Eddies will still develop but flow around the detached flank will enhance flushing relative to the present configuration. Thus the need for the culvert is eliminated. In fact, questions on the usefulness of this breakwater indicate it should be eliminated entirely.

These conclusions have been made from results whose methods have their own particular assumptions. The assumptions place certain limitations on the situations when these results are valid. The lack of field data places additional limitations on the model results because of an uncertainty in the calibration. However, the successful use of these models in other areas and good agreement with field data indicates the results of those simulations have given us good insight into the hydrodynamic behavior of concern to this study.

On the basis of these conclusions, the following recommendations are made. Plan A should be dropped for consideraton as a viable plan. Although adequate flushing is maintained in the upper harbor, there is a serious question concerning protection of the industrial area around Town Pier from waves generated from a southwest wind along the axis of maximum fetch. Plan D_2 should be retained only as an alternate choice. The short, western breakwater both restricts flushing relative to present conditions and may be unnecessary as a protection measure for the yacht club. If this protection is necessary due to damage suffered in the past, then the breakwater should be detached from the eastern shore to enhance flushing and eliminate entrapment. The use of a culvert through the breakwater in the present configuration is questionable, and the entrapment that the culvert is supposed to eliminate could better be reduced by detachment. The present arrangement Plan D_2 shows that the trade-off for more protection would be a decrease in the flushing rate of the upper harbor relative to the present situation of no breakwater and to the other two plans. Detachment to enhance flushing would decrease the amount of higher concentration water in the upper harbor, but without additional work, it is not clear how much of a reduction is possible. Plan D_1 appears to fit the criteria of good flushing and adequate protection, and these results support this configuration as first choice for construction.

In the context of this study area, there does not appear to be any particular reorientation which would enhance flushing. The length of the short western breakwater of Plan D_2 appears to be near minimum to serve as protection for the yacht club. If it is required, then the breakwater should be detached from the western shore to enhance flushing and eliminate entrapment. The length of the dog-leg breakwater (D_1) depends on how much protection should be afforded to industrial areas around Town Pier. If the need for protection is limited to the area between Town Pier and the U. S. Coast Guard Station, then the breakwater could probably be shortened by a few hundred feet. This dog-leg configuration seems to be better in terms of protection than on equivalent straight breakwater for this area.

The design storm is taken from the maximum winter winds as recorded at Providence, RI (TRIGOM, 1974). These winds were measured at 44 knots or 22.6 m/sec from the southwest which is along the axis of maximum fetch. Although these are maximum winds that are not sustained long enough to fully arouse the water, they do represent an upper limit that is useful as design criterion. Using the formulations of Darbyshire (1956) for fetch-limited waves one determines that the significant wave height H_s is 5.0 feet or 1.5 meters, and the significant wave period T_s is 3.3 seconds. Using the Shore Protection Manual (CERC, 1973), the equivalent wavelength L is 54.2 feet or 16.5 meters for a depth of 16 feet or 4.9 meters.

This wavelength becomes a unit of measure for the wave diffraction diagrams in the Shore Protection Manual (CERC, 1973). We assume here that the dominant wave property is diffraction and the approach of the wave crest is 75 degrees. Overlaying the dog-leg breakwater (1100 + 600 ft) of Figure 2 on an extrapolated wave diffraction diagram, two points are evident. First, the height outside the breakwater is reduced by 50% at the northern end of the industrial region. Second, along the southern half of the industrial area, which includes the Town Pier area, the wave height is reduced by 88% or more. The breakwater can be shortened by 400 feet or 122 meters (700 + 600 ft) which keeps the Town Pier area in the area of reduction of 88% or more. However, the northern end of the industrial region has a reduction in wave height by only 25%. The northern quarter has a reduction by 25 to 50% and the southern quarter by greater than 88%.

The present configuration of Plan D_1 allows for adequate flushing of the inner harbor which would be almost as good as harbor flushing without any breatwater(s). Although increasing the length of the breakwater by, say 400 feet, would mean more protection, flushing would be similarly retarded as in Plan D_2. Shortening the breakwater would decrease protection, but would not necessarily provide a significant increase in flushing. The length in Plan D_1 is considered optimal given the present orientation of the breakwater. A change from the present orientation is, likewise, rejected as a mechanism to significantly enhance flushing. If the orientation was significantly changed, then the breakwater would have to be lengthened to provide the same level of protection as Plan D_1. However, lengthening the breakwater would retard flushing which would negate the effect of changing the orientation. Considering the length and orientation of the breakwater with respect to flushing and protection, the present dimensions and orientation of Plan D_1 are considered optimal.

-Report-

N.E. Division
U.S. Army Corps of Engineers

Breakwater
Bristol Harbor
Bristol, Rhode Island

Stonington Seafood Products, Inc.

June 1, 1981

(203) 535-3241
(203) 535-3246

Stonington Seafood Products, Inc.
WHOLESALE DISTRIBUTOR
Specializing In Deep Sea Lobster
STONINGTON HARBOR
4 North West St. Stonington, Ct. 06378

June 1, 1981

Col. C. E. Edgar III
Corps of Engineers
Division Engineer
U.S. Army Engineer Division, N.E.
424 Trapello Road
Waltham, Massachusetts 02154

Dear Sir:

The attached report is submitted for consideration in your evaluation of the authorized Breakwater for Bristol Harbor, located in Bristol, Rhode Island.

The estimated commercial fishing benefits have been calculated in accordance with NED Benefit Evaluation Procedure for Commercial Fishing.

This report is considered propriority and should not be released outside U.S. government agencies without prior approval of Stonington Seafood Products, Inc.

Should further information concerning our proposal be required, please contact the undersigned.

Very truly yours,

STONINGTON SEAFOOD PRODUCTS, INC.

Alan Guimond
President

When Congress enacted public Law 94-264, the Fishery and Conservation and Management Act of 1976, better known as the 200-mile fishing zone, the US fishing industry was given a unique opportunity for growth in areas that have been before dominated by subsidized foreign vessels.

In one particular area, the US government has set as a priority, the harvesting of what is commonly referred to as under-utilized species. On the east coast, these are predominantly the red and silver hakes, butterfish, and the squid family. In 1979 and 1980, the US industry capacity to harvest these species resulted in a surplus of close to 100,000 metric tons. These quantities were made available to various foreign countries, particularly Japan, the Soviet Union, Italy, Spain, and several eastern European countries. With the invasion of Afghanistan by the Soviet Union, the US withdrew its permission and cancelled all licenses extended to the Soviet Union for fishing within our 200 mile limit. As a result, the need for certain products which were predominantly harvested by the Soviet Union has created a shortage in many eastern European countries that did not exist prior to curtailment.

The purpose of this proposal is to look at the development of an entirely new fishery based in Bristol, RI, providing a breakwater is built to protect the Bristol waterfront. A major requisite is adequate facilities to home-port vessels which would harvest these under-utilized species. Prior to 1981, the concept was that vessels currently engaged in other types of fishing activities in the New England area would re-direct their efforts towards these under-utilized species. However, the changing of habits has brought this about in a very slow manner. It is difficult to take fisherman who are making a living, some more adequately than others, and ask them to go into a venture that is unfamiliar. They tend to continue with their traditional ground fish operations and go after what we call the "money fish", playing the pricing market. This policy does not allow for large volume, low-price species to be harvested in an effective manner. In addition, the types of vessels in the New England area do not carry refrigeration which is one of the major features necessary to harvest some of the many fragile under-utilized species.

Our plan is to establish a consortium involving foreign and domestic companies commonly referred to as a joint fishing venture. Essential elements of the venture would be that US interests would provide the harvesting vessels and the land-based support facilities, and the foreign interests would provide the processing vessels and, in cooperation with the US companies, the marketing. The advantage of going after these under-utilized species, specifically the hakes, is that there exists a market in East European countries that has been satisfied previously by other foreign countries. However, because of political and social conditions, the US government's emphasis has changed in that US vessels are getting more of a priority, and foreign countries will not be allowed to fish within our zone unless they specifically encourage, and if not actually consummate contractual arrangements with the US companies via the US Commerce Department. All unnecessary trade and tariff barriers are to be reduced, otherwise foreign government owned or subsidized vessels will not be permitted to fish in the US zones.

It is our intention to acquire, either by purchase (or lease with purchase agreement) some twelve to fifteen, 80 to 90-foot vessels which are currently tied up in the Gulf Coast areas. These vessels are not being fished at this time. The depressed condition of the shrimp industry in the Gulf of Mexico has made fishing uneconomical, and therefore, they are either being tied up or are going into receivership. The configuration of these vessels, including a majority with on-board refrigeration systems, are attractive to our joint venture, particularly where we will be taking vessels that are tied up, are available at a very reasonable price, and contain all the necessary equipment to harvest the species mentioned above. With an approximate value of $500,000 each, the harvesting fleet will have a total worth of between 6.0 and 7.5 million dollars. Since we will be owning or leasing all of the vessels engaged in this joint venture, the control and management of them will be concentrated and will provide for maximum efficiency. The vessels involved will be manned and experienced American captains who possess the knowledge and skill necessary. These vessels will deploy for 4 to 5 days at a time, on the red and silver hakes. Due to the biological nature of the hakes, deteriation takes place rather rapidly and icing down is necessary. Therefore, when landing after 4 or 5 days, the first day's catch is not of equal quality as that caught on the last day. It is our intention that the fish will not be coming into port for off-loading and processing in the traditional manner, but will be processed at sea.

In this regard, two vessels of approximately 292-foot (see brochure) in length, with a dead weight of 1,000 tons will be sent over to: 1) fish under a normal foreign fishing license while at strategic locations off the US coast, and 2) strictly process the fish that would be captured by the US vessels which we will acquire from the Gulf of Mexico. This type of joint venture has successfully been conducted on the West coast and there are several that are currently being developed on the East coast. The advantages of these large processing vessels is that they can process the product quickly while the quality is at its highest. They can do it with machinery not currently available on US vessels and the volume which they can handle and the intensity of the crews which are needed make it a natural marriage between our vessels and theirs. In addition, the intent is to process the product in a very rough form; headed, gutted, and frozen. The product will then be shipped to a processing facility in an eastern European country which would then complete processing and distribution thru an already established marketing system.

Conservatively, with twelve US owned harvesting vessels making thirty-five trips of four days duration, there will be 1680 days of fishing each year. The average daily catch of 20,000 pounds per vessel, currently selling at eight (8) to sixteen (16) cents per pound will produce an annual catch valued at $2,688,000 to $5,376,000.

It is anticipated that a higher price (.20/lb. or more) may be realized due to the unique operation being developed. Normal operating costs of this operation will approximate fifty percent of the gross catch value.

Each dollar's worth of fish landed or harvested will expand the local economy by $4.00 resulting in over 20 million in new monies being infused into Bristol, and Rhode Island.

There are several advantages as to why the proposed facility in Bristol is a very important one. The location of the fishing grounds for the hakes is predominantly south of Cape Cod. This type of venture located in Maine, Gloucester or Boston is not efficient in time and cost of energy. In addition, these harbors and ports are themselves over-taxed at present with US vessels. The recent expansion of these fleets precludes any major shift of new vessels into these ports. Smaller ports on Cape Cod cannot accommodate the types of vessels that are needed in this venture.

New Bedford is overtaxed with its own fishing fleet which has continuously grown in size over the last five years.

The vessels that may be home-ported at Sakonnet Point, RI, would come out of the Newport area, which itself has turned towards tourism, and is slowly closing out the commercial fishing industry.

Quonset Point, and Davisville have been identified by the state as predominantly off-shore oil support facilities, and are presently being utilized for this purpose.

Mellville, while presently vacant, will be fully utilized under programs being developed by the State of RI, and private interests and will be unable to accommodate our vessels.

Point Judith, one of the larger port facilities on the East coast, currently is lacking in pier space for its present tenants. If plans for expansion in both pier facilities and the fishing fleet take place in the next three to four years, as expected, there will still be a shortage of berthing that will not be met by the State of RI.

Stonington Conn., the only other viable port, does not currently have adequate facilities to support its small fleet. Long Island causes support problems to the vessels themselves, and the cost to make that long a trip is not economical.

We will proceed with the joint venture only if we can find an adequate home-port to support our vessels. Adequacy takes the form of not only pier facilities, but adequacy in support, services, manpower to make repairs, and proximity to shipyards to make major repairs. There are several within one hour steaming time of Bristol where experienced workers are available.

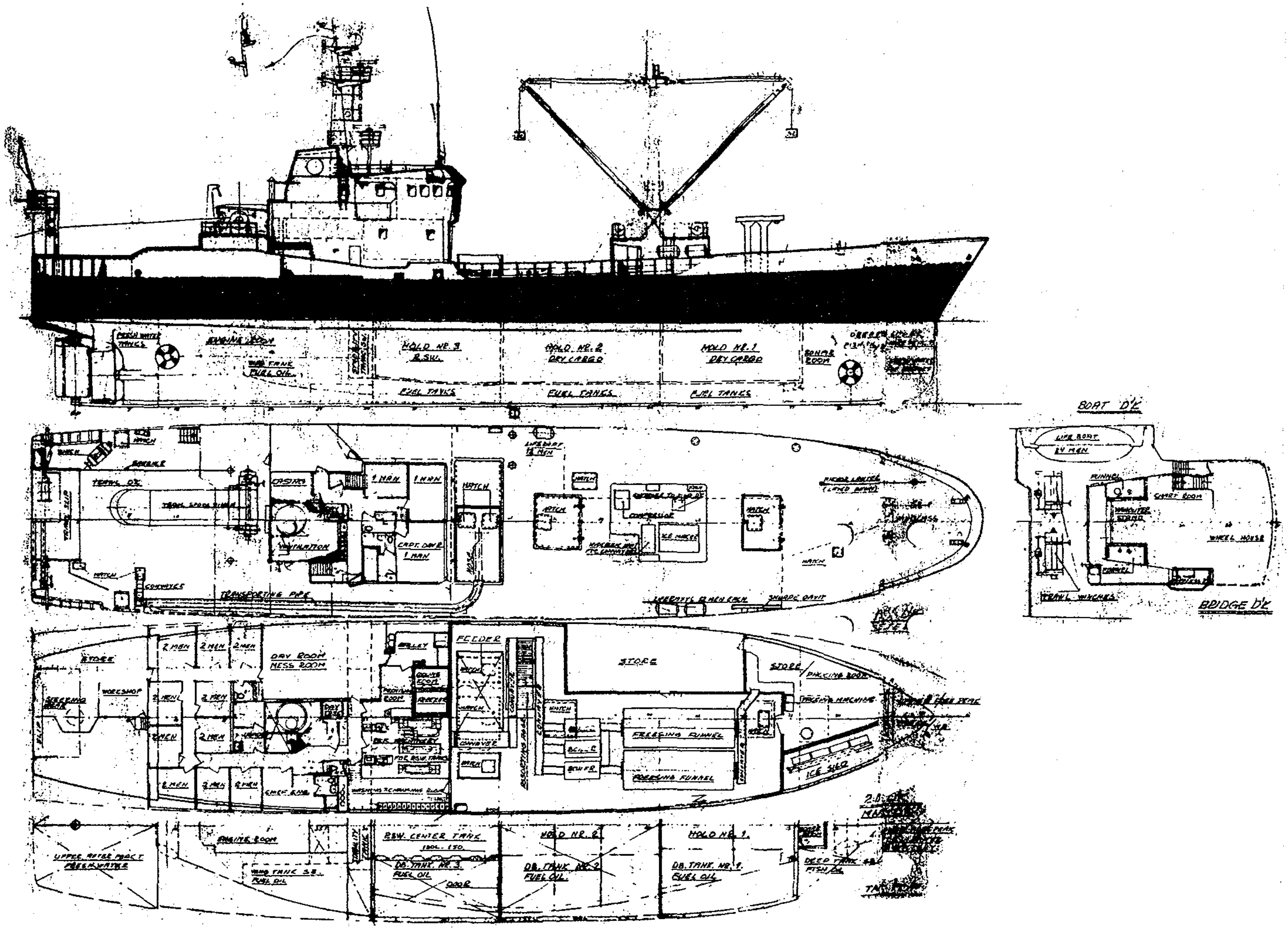
Bristol, in cooperation with the state, has taken a positive step in that it wants to have its commercial fishing regenerated. Bristol has a long history of commercial fishing, shipping and boat building.

We want the project to be financed from a business point of view, a social point of view, and the economics dynamics of the industry. It is a clear perfect example of US industry and private interest, but also for the interest of the public at large. There is no industry that could offer such a complimenting marriage between local, state, and regional interests, and the national goals of reducing the balance of trade. There is no better place for monies to be spent than on this type of project that will realize untold economic benefits both directly by the vessels harvesting the fish, directly by the people involved with the harvesting, indirectly by the people in companies supporting these vessels, and the potential economic welfare and well being of the local community.

We stand ready to provide any additional information that the Corps of Engineers may deem appropriate and we make ourselves available to your staff to go over any aspects of the proposal. We want our proposal to be scrutinized closely, because the closer it is scrutinized, the more it will be realized that this is a good, valid proposal that we want to happen.

We feel so strongly, that whatever types of commitments or guarentees that the Corps may like to see, we feel that we can render such guarantees to both the Corps and the local community. We thank you for your assistance, and are hopeful that a favorable decision on the Breakwater will be forthcoming.

F/V FISHING FUTURE



Machinery

One NOHAB engine type F 216 V-D 825 developing 3520 HP at 825 RPM. CP propeller of make I W Berg. A CURT nozzle and a Becker flap-rudder are fitted.
Three auxiliary sets. MWM type TBD 232-V12, developing each 378 HP at 1800 RPM.
PARAT steam pressure aggregate with 7 kg. steam pressure. Provides 1000 kg. steam per hour.
Refrigerated machinery (R22) of make Kvaerner is installed for following purposes:

- Cooling of sea water for RSW tanks with a capacity of 80 tons of sea water per hour from 15 degrees C to 2 degrees C.
- Maintaining -30 degrees C in cargo holds.
- Freezing capacity 20 tons shrimps/24 h.
- Ice freezing, capacity 10–12 tons/24 h. To a temperature of 40 degrees C.

Navigational and fishing instrumentation

- Decca Radar RM 926
- Loran LC
- Simrod SSB radio telephone
- Plath radio direction finder
- Simrod VHF type PC3, 2 × 16 channels
- VHF direction finder (Taio)
- Echo Sounder and Sonar:
  Simrod Sonar type Su 2 (retractable)
  Simrod Echo Sounder EK 38
- Trawl-eye of type Simrod FB2
- Furuno radar 10 cm Range 100
- Faximilier, Decca Track Wrighten

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Flekkefjords Mekaniska Verkstad. 1976.

OWNER:

TECHNICAL SPECIFICATIONS

Hull

Length o.a.	60.80 m
Lenght p.p.	54.60 m
Breadth m	12.00 m
Depth m	7.60 m
Deadweight abt	1000 tons
Tonnage abt	770 Grt

The vessel is flush-decked and has a continuous factory deck.
Two cargo hatches are served by 2 × 5 t and 1 × 1.5 t winches.
There is provided one bow and one stern side Thruster each of 450 HP.
Two insulated cargo holds of totally 627 m³ capacity are arranged for storing the catch at -30 degrees C.
There is one centre installed sea water (RSW) fish tanks holding the immediate fish catch at around 4 degrees C.
A total bunker capacity of 290 m³ is arranged in the double bottom and in deep tanks, giving a steaming range fc 20 days at 100 % output or approximately 32 days at average 50 % output.
Stabilizing tank is provided. This can be utilitized to increase the bunker capacity by 150 tons approximately.

Class etc.

The vessel is classed with Det Norske Veritas with the nota tion + 1AI "Deep Sea Fishing", Ice C. EO. The vessel shall satisfy Swedish national regulations.

Accomodation

Accomodation of hig standard is arranged for 21 men. The captain and Chief Engineer and mates have single cabins. The accomodation is air-conditioned. Special sound proofing arrangements are installed.

SUPPLEMENTAL ECONOMIC ANALYSIS
ESTIMATED COMMERCIAL BENEFITS

BRISTOL HARBOR, RHODE ISLAND

PREPARED BY
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
NEW ENGLAND DIVISION

SEPTEMBER 1981

SUPPLEMENTAL ECONOMIC ANALYSIS
ESTIMATED COMMERCIAL FISHING BENEFITS

BRISTOL HARBOR, RHODE ISLAND

INTRODUCTION

This is a supplement to the July 1980 economic appendix to the Bristol Harbor Navigation Study. It was commented in that appendix that no significant increase in commercial fishing activity could be expected as a result of the construction of a breakwater to protect Bristol Harbor. That appendix limited its attention briefly to the conch and quahaug fisheries. The purpose of this supplement is to more thoroughly access the potential of Bristol as a commercial fishing port. Input to this supplement comes from a number of expert sources, including National Marine Fisheries Service, Rhode Island Department of Environmental Management, US Fish and Wildlife Service and the University of Rhode Island, Department of Marine Resources. The comments presented herein represent a consensus of opinion from these sources.

BRISTOL AS A COMMERCIAL FISHING PORT

Inshore Fishery

Bristol is an inshore fishing port involved almost exclusively in the quahaug fishery. Two thirds of the quahaugging takes place on the west side of Narragansett Bay serving markets in East Greenwich and Wickford. The other third takes place on the east side of the bay, mostly around Ohio Ledge, Patience and Prudence Islands. There does not seem to be any predictable relationship between the proposed breakwater and the future of quahaugging. Rather, the quahaug fishery is sensitive to pollution, the general state of the economy and of course the resource limit.

The quahaugging industry looks better now than it has for some time with respect to the pollution constraint. The pollution line has been receding, giving rise to more ground to rake. Quahaugging attracts many part-timers who look for an income supplement by selling their harvests. The number of part-timers increases substantially when the economy is hurting. There are limits to the quahaug resource, and concerns have been expressed for the future of this stock.

Offshore Fishery

Bristol is not considered to be an attractive location for an offshore fishing port. Its location is considered to be too costly in terms of both steaming time and fuel cost. There are not adequate port facilities in Bristol and no strong seafood industry. Essentially, developing Bristol as a commercial fishing port would involve starting from scratch. It is felt that the money that such development would cost could be put to far better use elsewhere. Many feel that Rhode Island has a surplus of potential fishing ports although it is admitted that most of them are not well developed for commercial fishing operations and/or are overcrowded.

Davisville/Quonset, for example, is a candidate for commercial fishing operations. This was originally designated by the State of Rhode Island exclusively as an offshore oil port. However, oil expectations have been revised downward. In particular, Baltimore Canyon projections have been revised downward. There is apparently a small supply of natural gas but not enough for commercial operations. Thus the remaining hopes are pinned on Georges Bank. The consequence of this downward revision of Atlantic petroleum supplies is that the state doesn't need the entire Davis/Quonset area for an exclusive offshore oil port. The state may now consider the area for multiuse to encompass commercial fishing.

Bristol Harbor with a Breakwater

Bristol Harbor would certainly be improved with a breakwater. A breakwater would possibly act as a stimulus for the building of docks.

Because of shifting price structures it is not possible to say if or at what rate Bristol would develop as a commercial fishing port. Boats would land harvests at Bristol if prices warranted it. Landings would move from port to port on a seasonal (shifting price) basis. Alternative ports would for example include New Bedford, Stonington, Montauk Point, etc. New England vessels have traditionally stayed close to their home port but that tradition is beginning to change.

Bristol represents a possible future for ocean (mahogany) quahaugs. At the present time Blount (Warren, Rhode Island) is the dominant buyer of ocean quahaugs.

CONDITION OF THE FISHING INDUSTRY

The fishing industry in the United States generally is in disarray. Some of the most frequently cited problems are:

- High cost of fuel
- High cost of capital
- Undeveloped (or poorly developed) markets (both domestic and foreign)
- Inadequate quality of product
- Lack of adequate port facilities
- Price instability
- Resource management constraints

Marketing is generally held to be the key problem. If markets do open up, especially with respect to nontraditional fisheries (hake, squid, mackerel, butterfish, etc.), it is felt that fishing interests would capitalize. One correspondent felt that new growth would take place, perhaps on the order of 5 - 10 vessels per year of the 60 foot - 90 foot variety. It is felt, however, that this growth would not be dependent on Bristol if other facilities were available.

JOINT VENTURES (GIFA'S)

The concept of joint ventures between US harvesters and foreign processing ships has arisen as a spinoff to the recently implemented 200 mile Fishery Conservation Zone. The joint venture attempts to solve both marketing problems and problems of quality.

A joint venture is more technically known as a Governing International Fisheries Agreement (GIFA). The GIFA (or joint venture) is negotiated between the government of a foreign country and the government of the United States. Permits are issued by the National Marine Fisheries Service (NMFS). Basically the foreign country recognizes the United States sovereign rights over all fish (except tuna) within 200 miles. In 1981 the United States had GIFA's with: Bulgaria, Cuba, European Community, Faroe Islands, German Democratic Republic, Japan, Republic of Korea, Mexico, Portugal, Romania, Spain, Taiwan and USSR. There are no GIFA's with Canada or countries commonly used as flags of convenience.

Application for a GIFA is made to the NMFS through the US Department of State. It is reviewed by the public, USCG, Department of State and United States Congress. The entire process usually takes four months, although it can be shortened to two months. Permits are issued with appropriate conditions and restrictions. The conditions and restrictions limit the operation to specific species, quantities, geographic areas of the fishery, number of vessels and gear to be employed, seasons, total length of time (usually one year limit), incidental catch, etc.

Stonington Seafood Products Proposal

Stonington Seafood Products (SSP) filed a report dated 1 June 1981 with the New England Division, US Army Corps of Engineers indicating their desire to enter into a joint venture (GIFA) with Sweden provided a breakwater is built at Bristol. In essence the report states that if a breakwater is built in Bristol, a fleet of approximately 12 - 15 idle Gulf Coast shrimpboats will be home ported in Bristol Harbor. As part of a US/Swedish joint fishing venture these boats would engage in harvesting hake and delivering the harvest to two Swedish processing vessels deployed in the fishing grounds. The product after initial processing would be frozen and shipped to an eastern European country for completion of processing and distribution through an established marketing system. The report goes on to estimate a net annual benefit of \$2.7 - \$5.4 million. The proposal was discussed with all of the agencies mentioned in the Introduction to this supplement. A consensus emerged on a number of points:

1. Implementation of the joint venture proposal.

Implementation of the joint venture proposal is uncertain due to bureaucratic hazzards and politics. Furthermore even if a joint venture agreement is implemented for one year as is customary, there is no way to predict the extent of renewability of the agreement in the future.

2. Likelihood of Success

Once implemented the success of the joint venture would be positively influenced by several factors. There are also several concerns.

Positive Influences

- The silver hake resource appears to be sufficiently abundant to support the venture. Figures show that in Georges Bank the combined US/foreign harvest of silver hake dropped dramatically following the implementation of the Fisheries Conservation Act of 1976 which established US jurisdiction within 200 miles of the coast. The total harvest in Georges Bank dropped from over 44,000 metric tons to about 10,000 metric tons. Nearly all of this reduction resulted from the cessation of fishing in these waters by the USSR. While not as dramatic, harvest data from the waters of southern New England and the mid-Atlantic also show a decline in foreign fishing activity. The departure of foreign fishermen from the waters off New England has resulted in a vastly increased potential for US harvesters. It should be remarked that even before implementation of the FCMA the total harvests of silver hake in both Georges Bank and the waters of southern New England and mid-Atlantic were decreasing due to overfishing. However, with the exodus of foreign vessels, it appears that fisheries stocks are rebounding. This is discussed in detail in the October 1970 draft report The Status of the Marine Fishery Resources of the Northeastern United States issued by the Northeast Fisheries Center, Woods Hole, Massachusetts.

- The proposed foreign partner (Sweden) brings into the joint venture the expectation of an in place and reasonably sophisticated marketing and distribution system for European consumers. Without the marketing advantages offered by the joint venture, the United States fishing industry will find it difficult, if not impossible to penetrate foreign markets in the short run. Fishing interests in foreign countries are very protective of their existing markets and apparently have considerable political influence because duties on imported fish products are in many cases very high. There does seem to be some evidence of a softening on the part of European consumers with respect to the lowering of tariff barriers. This is a consequence of unfulfilled consumer demand in some European countries. Another very important marketing requirement which the joint venture promises to satisfy concerns the quality of fish products. The delivery of harvests of silver hake directly to processing ships which are deployed on the fishing grounds should result in quality of a sufficiently high level to meet the requirements of foreign markets.

Concerns

- Shrimp boats are not suited for New England waters. According to the 1980 report Commercial Fishing Facilities Needs in Rhode Island, prepared by University of Rhode Island, shrimper designs lack the stability to operate safely in New England's rough seas. They are not built for winter fishing on Georges Bank or the mid-Atlantic fishery. They would not be likely to operate offshore from mid-November to mid-March. The design of these boats include western rig, hard chined steel hull with relatively shallow draft, large superstructure with tall masts and long booms. According to the report, New England fishermen are beginning to look to traditional hull designs more suited to our own waters. It is likely that European trawler designs which evolved from vessels similar to traditional New Engalnd draggers will become more popular in New England.

- If the silver hake fishery were profitable harvesting would probably already be taking place on a large scale. New England fishermen are accustomed to fishing for relatively low volume/high priced fish. As diesel fuel escalates rapidly in cost and with many of the fishing boats consuming upwards of 30 - 40 gallons per hour, fuel costs are becoming a major operating constraint as they claim an increasingly large share of the gross revenue. Silver hake brings very low ex-vessel prices (8 - 16¢ per pound currently) to fishermen. A different style of fishing gear and boat is required for this fishery. Vessel and gear costs have risen dramatically in recent years. As a result costs of financing the new equipment is of major concern. With the economy under stress, financing a venture to exploit a fishery giving marginal returns is unattractive.

- If the proposed joint venture were authorized, there would be no way to insure that the harvesting vessels limit their fishing activities to the authorized (underutilized) species. Variable marketing opportunities offer incentive for boats to change from one fishery to another over the course of a year.

- The freezing facilities aboard the harvesting vessels are of questionable utility in view of past experience with the hake fishery. The mother ship (processing ship) ordinarily steams right along with the fleet of harvesting vessels. The harvesting vessels transfer their catches directly from the nets to the processing ship. Thus the freezing facilities aboard the shrimp boats are not considered .

- There is some discrepancy with regard to the size of the processing vessels. In the SSP report it states that the two vessels are each approximately 292 feet long. He makes reference to a brochure which specifies the length to be 60.80 meters. This is equivalent to

$$\frac{60.80 \times 39.37}{12} = 199.47 \qquad \text{say 200 feet.}$$

- Another discrepancy appears to exist relative to the freezing capacity of the processing vessels. The brochure provided by SSP gives the (shrimp) freezing capacity of each processing vessel to be 20 tons/24 hours. This gives a total 24 hour freezing capacity of 40 tons/day for the pair of vessels. On the other hand the economics presented in the report assumes a total fleet harvest of about 110 metric tons per day:

  (12 boats x 20,000 lb/boat ÷ 2204.6 lb/metric ton
  = 108.86 tons per day)

  Thus the assumed harvest would be nearly three times the capacity of the at sea processing capability. Even if we were to assume that the 110 tons were harvested on a 4 day basis and were then transferred to the processing vessels over a 7 day period, the average daily total harvest would be

$$\frac{110 \times 4}{7} = 62.86, \qquad \text{say 63 tons}$$

  This is still more than 50 percent in excess of the processing capacity.

3. Importance of Bristol

- Neither Bristol Harbor nor the concept of a concentrated fleet of harvesting vessels appears to be critical in the establishment of a joint silver hake fishing venture. Presuming the venture can be economically justified, there appears to be no prior reason why a distributed fleet would not be feasible. This is practiced in other fisheries. It is recognized, however, that there exists a potential for certain economics of scale if the 12 harvesting boats were home ported in one location. Thus the construction of a breakwater at Bristol does not appear to be a necessary condition for large scale exploitation of the silver hake fishery. Furthermore, the breakwater by itself does not provide a sufficient condition. While a breakwater might well act as a catalyst for attracting a fishing fleet to Bristol, a number of ancillary services are also required such as marketing, offloading facilities, ice, fuel, ships store, repair facilities, transportation, sewage disposal, water supply, electricity, etc.

Bristol Harbor is not mentioned in the 1980 University of Rhode Island report Commercial Fishing Facilities Needs in Rhode Island. The ports discussed include Galilec, Newport, Coddington Cove, Melville, Quonset Point, Davisville and Sakonnet Point. Bristol Harbor is located about 5 miles further from the fishing grounds than Melville. The report comments that "Melville's position almost halfway up the bay is a drawback to fishermen especially day trip and short trip fishermen who are becoming ever more conscious of the strain that increased fuel costs and extra steaming time places on their earnings."

It is felt that Bristol per se is not the critical element in establishing a hake fishery. There are several ports which could accommodate all or some of the harvesting vessels, (e.g. Provincetown, Boston, Newport, Gloucester, etc.).

BENEFIT ANALYSIS OF SSP PROPOSAL

a. Assumptions From SSP Proposal

- 12 harvesting vessels

- Maximum processing capacity of processing vessels is about 88,000 lb.
(40 metric tons x 2204.6 lb/metric ton)

- Average selling price is 12 cents per lb
(Proposal assumes range of 8 - 16 cents)

- Each vessel will make 35 trips of 4 days each which gives 140 days of fishing each year.

b. Additional Assumptions From NED

- Maximum of 8 month fishery
(Gulf shrimp boats cannot fish offshore in winter)

- 50 percent chance that the proposal for the joint venture would be implemented.
(Substantial uncertainty due to bureaucratic and political considerations)

- 75 percent chance that the joint venture agreement would be renewed for each additional year for the remainder of a 10 year period.
(A joint venture is essentially an agreement with a 1 year term.) Following the issuance of the initial permit it is thought that renewals are more likely but by no means certain.

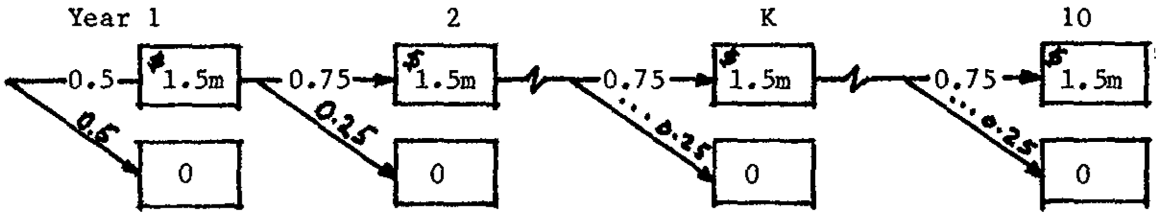
- No chance that the joint venture agreement will be renewed after 10 years.
(Joint venture arrangements are meant to be temporary arrangements only. They are meant to take up the slack until the US fishing industry is capable of harvesting, processing and marketing the entire fishable resource within the 200 mile Fishery Conservation Zone.

c. Benefit Computation

If the joint venture is implemented the annual catch would have an average value of about $1.5 million.

(88,000 lbs/day x 140 fishing days/yr x $0.12/lb)

The following tree diagram depicts the probabilistic nature of the joint venture continuing for various durations up to 10 years.



The numbers in the boxes represent cash flows. The upper row of boxes represents the state of the system provided the joint venture endures through the year indicated. When the joint venture is terminated the system branches to the appropriate box in the lower row. Once the joint venture is discontinued we assume it will not be reinstated. Thus we obtain mutually exclusive joint venture scenarios of 1, 2, 3, . . . 10 years respectively. The numbers on the arcs represent probabilities of moving from the prior state to the next.

The outcomes (cash flows) and probabilities can be combined to give an expected present value. The table below summarizes this computation:

No. of Yrs Joint Venture Endures K	Probability That Joint Venture Endures for K Consecutive Years		(7-5/8%) Present Value of Annuity of K Consecutive Annual Cash Flows of $1	Expected Pres. Value of K Consecutive Annual Cash Flows of $1.5 Million
1	(.50)(.25)	=0.125	0.92915	174,216
2	(.50)(.75)(.25)	=0.094	1.79248	252,740
3	$(.50)(.75)^2(.25)$	=0.070	2.59463	272,436
4	$(.50)(.75)^3(.25)$	=0.053	3.33996	265,527
5	$(.50)(.75)^4(.25)$	=0.040	4.03248	241,949
6	$(.50)(.75)^5(.25)$	=0.030	0.67594	210,417
7	$(.50)(.75)^6(.25)$	=0.022	5.27382	174,036
8	$(.50)(.75)^7(.25)$	=0.017	5.82933	148,648
9	$(.50)(.75)^8(.25)$	=0.013	6.34549	123,745
10	$(.50)(.75)^9(.25)$	=0.009	6.82507	92,138
				1,955,851

Thus the expected present value of all future cash flows is $1,955,851.

This expected present value must be annualized at 7-5/8 percent over a 50 year period.

Annualization factor for \$1 of present value

$$A\,(P,\ 7\text{-}5/8,\ 50) = 0.07823$$

Hence the expected annual cash flow benefit due to the SSP proposed joint venture is

$$(0.07823)(1,955,851) = 153,016, \quad \text{say } \$153,000$$

SYLLABUS

Bristol Harbor is located on the east side of Narragansett Bay, about 13 miles southeast of Providence and 12 miles north of Newport, Rhode Island.

An offshore Federal rock breakwater project was authorized in August 1968 by Congress to protect the harbor from storm waves; however the project was not funded until FY 1979.

The original project was reviewed to determine if the project is still needed; if local interests still desire the breakwater and are willing to participate in the cost of construction; if the location and length of the structure provide the optimum protection; and if the proposed breakwater complies with updated environmental criteria and the Water Resources Council's Principles and Standards. These items are addressed in the report.

Several alternative plans were studied and analyzed to determine the optimum improvement plan to provide for present and future commercial and recreational navigation needs and related activities.

Based on the results of this study, the selected plan of improvement is Plan B, consisting of a 1700-LF offshore, dog-leg, rock breakwater located 300 feet south of the U.S. Coast Guard pier at the east side of the inner harbor. It would have a 1600-foot-wide navigation opening to the west of the breakwater and a 400-foot-wide water circulation opening to the east of the breakwater.

The estimated cost of the selected plan is $6,091,000 and it is economically justified. The study economics indicates a 65% Federal and 35% local cost allocation, however, the cost sharing percentages in the authorizing legislation dated 13 August 1968, mandated the cost sharing percentages to 64% Federal and 36% local. The interest rate was subsequently fixed at 3-1/4 percent. Therefore, the Corps of Engineer cost would be $3,894,500 (64%); the U.S. Coast Guard cost would be $6,500; and the local cost would be $2,190,000 (36%). Annual Benefits would be $772,000 and Annual Charges would be $261,000, resulting in a favorable benefit-cost ratio of 2.96 to 1.0.

Maintenance of the proposed project would be a Federal responsibility, contingent upon the availability of future navigational maintenance funds, the continuing justification of the project, and the environmental acceptability of required maintenance activities.

The Division Engineer recommends that the rock breakwater authorized by the 1968 River and Harbor Act for Bristol Harbor be constructed in accordance with the modifications described in Plan B of this report, subject to the conditions of non-Federal (local) cooperation.

The harbor is landlocked on three sides, but is exposed to the south. Present use of the harbor becomes difficult whenever winds in excess of 12 miles per hour occur, as passage to and from the moored boats by dinghy is hazardous. Use of the harbor is severely hampered whenever winds of over 20 to 25 miles per hour occur from southerly directions, due to waves generated by the wind, and considerable damages occur annually to boats when their moorings break during the high winds. Storm driven waves also damage the wharfs and piers along the east shore of the harbor.

The open exposure of the harbor reduces the recreational boating season from an average of 170 days, which is enjoyed in other areas throughout Narragansett Bay, to 150 days, as well as prohibits ancilliary shoreline development in the commercial/industrial area along the east shore.

No existing endangered or threatened species have been identified in the study area.

CONDITIONS IF NO FEDERAL ACTION TAKEN

If the proposed breakwater is not completed, the present navigation problems associated with southerly waves can be expected to continue. The present low recreational boating growth will probably decrease further and shoreline damages will continue. The opportunity to provide environmental quality enhancement and additional economic stimulation to the locality from new facilities will not be realized.

PROBLEMS, NEEDS AND OPPORTUNITIES

A large number of local shellfishermen unload their catch at the Gilbert and Quitos Seafood Company docks, located on the east shore, north of the State pier and ferry landing. During southerly winds, unloading their catch from 14-foot to 20-foot outboard motor boats becomes very difficult, as well as dangerous. At times the shellfish have to be unloaded at other docks or ports and trucked to the shellfish companies. Outboard motorboats have been heavily damaged or sunk while unloading or tied up at Gilberts dock. There was also a 50-foot boat which sank at Gilbert's dock during a heavy storm in 1975. There is a need to provide protection for the smaller shellfishing boats from southerly storms.

The southerly exposure also reduces recreational boating activity in the harbor. The problems experienced by the recreational fleet under present degrees of wave conditions discourage full potential use, partly because of the difficulty in mooring and unmooring during periods of moderate to somewhat stronger winds, or in going to and from the anchored boats in smaller craft and dinghys. The accumulated effect of these various problems restricts the use of the fleet to about a 150-day season, compared to an average of a 170-day season in other areas of Narranganset Bay. In addition, transient visits to the Bristol Yacht Club and Bristol

Marine Boat Yard are curtailed when southerly winds are forecast. Local interests feel a breakwater is needed to provide both protection to the existing recreational boating fleet and the opportunity for future expansion.

With the trend to trailered boats, which is partly due to a lack of protected anchorages within the harbor, the town boat-launching ramp at Independence Park is heavily used. During southerly winds the waves in the harbor cause surging conditions at the ramp and it becomes difficult and time consuming to launch and retrieve boats.

Under storm conditions, the municipally owned docks and piers receive varying degrees of damage. An annual budget of $2,000 is allocated to the harbormaster for repairs of the docks. Other shore structures at Gilberts, Quitos and the Bristol Yacht Club suffer periodic damages, and shoreline erosion occurs at the head of the harbor.

The wave conditions within the harbor at the Bristol Yacht Club preclude standard marina-type slips and most of their sailing fleet is forced to anchor offshore at moorings. If harbor protection is provided, the yacht club would have the opportunity to construct a system of boat slips to accommodate a large portion of their fleet and reduce the hazards associated with offshore moorings.

The U.S. Coast Guard Buoy Depot is located on the east shore, at the southernmost terminus of the commercial and industrial section of the harbor area. The outer end of the pier is constructed of timber piles and a concrete deck. The southerly side of the pier is used by larger Coast Guard boats up to 180 feet long, and the northerly side of the pier is used by smaller work boats and patrol boats. Significant wave heights of 4 feet are generated from the south, pass under the pier, and reflect off the vertical granite pier located at the Elks Home, adjacent to and north of the Coast Guard pier, thereby causing increased wave damages and hazardous conditions along that side of the pier.

The Prudence Island Ferry, located just north of the Armory at Church Street Dock, transports freight and passengers to Hog Island and Prudence Island. It is the main line of support for both islands. Southerly waves strike the ferry broadside as it docks or departs, making the approach hazardous.

The Elks Club dock was destroyed by Hurricane Carol in August 1954 and never replaced. However, members of the club have indicated that the dock would be replaced if some kind of harbor protection is provided.

The dock at the Castle Restaurant, at the head of the Harbor, was destroyed in the "Great Blizzard of 78." The owner said boating patrons used the dock while dining and he would replace it if harbor protection is provided.

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PLAN EVALUATION - PLAN A

PLAN DESCRIPTION

Plan A would provide for a 1,600-foot rubble rock breakwater with a top width of 10 feet at elevation 10 feet above mean low water and 1-1/2 on 1 side slopes, beginning at a point about 400 feet west of the end of the U.S. Coast Guard pier and extending in a northwesterly direction toward Popasquash Point. A 1,100-foot opening would remain on the west side of the harbor for navigation purposes.

IMPACT ASSESSMENT

Breakwater Impacts. A 1,600-foot breakwater was found to be necessary to provide sufficient area to adequately protect the existing boat fleet and for reasonable expansion of the recreational fleet during the life of the project. Dispersion patterns indicate that this plan will provide adequate flushing and that increases in tidal currents and tide levels would be minimal. The breakwater alignment will not protect the Coast Guard pier or portions of the commercial/industrial area on the east shore from southwesterly or southeasterly waves.

Navigation Impacts. The breakwater will block off the center of the harbor to navigation and the boats will be required to use the 1,100-foot opening to the west or the 400-foot opening to the east of the breakwater. Boats using the east opening could occasionally conflict with Coast Guard usage. This plan would protect 70 acres of the waterway and 490 mooring spaces.

Economic Impacts. Breakwater costs are based on utilizing rock from a local quarry in Tiverton, Rhode Island and ocean disposal of dredged material in Rhode Island Sound, at July 1981 price levels. Annual costs are based on a 3-1/4 percent interest rate, which was fixed at the time of authorization in 1968, and a 7-5/8 percent interest rate (present rate for comparison purposes). Analysis of costs and benefits is shown in Appendix F.

The estimated first cost of Plan A is $5,899,000. A summary of the project economics is as follows:

PLAN - A

Rate	Annual Benefits	Annual Costs	B.C.R.	Net Benefits
3-1/4%	$729,000	$253,000	2.88	$476,000
7-5/8%	$666,000	$474,000	1.41	$192,000

EVALUATION AND TRADEOFF ANALYSIS

Of the three breakwater plans considered, this plan provides protection for the second largest amount of harbor area. However, it leaves the commercial/industrial segment of the harbor and Coast Guard pier unprotected from storm waves from both southerly quadrants. Although the plan will allow adequate flushing, Plan B provides better flushing patterns.

COST APPORTIONMENT

The cost apportionment is based on the ratio of the general and local benefits to the overall benefits, and is as follows:

	3-1/4%	7-5/8%
Federal (General)		
Corps of Engineers 61%/62%	$3,595,000	$3,654,000
U.S. Coast Guard	6,000	6,000
Total Federal	$3,601,000	$3,660,000
Non-Federal (Local)		
Cash Contribution 39%/38%	$2,298,000	$2,239,000
Total Non-Federal	$2,298,000	$2,239,000
TOTAL	$5,899,000	$5,899,000

PUBLIC VIEWS

Views of Federal Agencies. The U.S. Fish & Wildlife Service estimates that 4.0 acres of quahaug habitat would be lost due to this plan and recommends that all quahaugs be removed from the area prior to construction. The U.S. Coast Guard is concerned about the safe access of their 180-foot buoy tender and suggested that the breakwater be shortened or moved northward away from the clear approach to the pier. In addition the Coast Guard is concerned about the possibility of accretion and silting which might occur, thereby requiring future dredging. The National Marine Fisheries Service recommended that current studies be made to determine if stagnant areas will be developed in the harbor.

Views of Non-Federal Agencies and Others. The Rhode Island Department of Environmental Management is concerned about tidal flushing patterns and accumulation of ice flows.

PLAN B

PLAN DESCRIPTION

This alternative was developed in response to the request of the Board of Engineers for Rivers and Harbors to establish optimum siting and sizing of a protective breakwater to best provide for all the needs of the harbor. The original breakwater was realigned to begin about 400 feet from the east shore and 300 feet south of the Coast Guard pier, to allow the 180-foot Coast Guard buoy tender to safely utilize the southerly berth along the existing pier. The breakwater extends 600 feet in a westerly direction and dog-legs to the northwest for a distance of 1,100 feet, for a total length of 1,700 feet.

IMPACT ASSESSMENT

Breakwater Impacts. This alignment would provide protection for the entire commercial/industrial area of the shoreline, as well as the Coast Guard pier. Current and dispersion mathematical modeling indicates that increases in tidal currents and tide levels would be minimal, and flushing patterns are better for this plan than Plans A or C.

Navigation Impacts. A 1,600-foot opening on the west side of the breakwater would remain for navigation use. However, the 400-foot opening on the east could also be used by smaller craft. This plan would protect 65 acres of waterway and 455 new mooring spaces.

Economic Impacts. The estimated first cost of Plan B is $6,091,000. Complete analysis of costs and benefits are shown in Appendix F. A summary of the project economics is as follows:

PLAN - B

Rate	Annual Benefits	Annual Costs	B.C.R.	Net Benefits
3-1/4	$772,000	$261,000	2.96	$511,000
7-5/8	$720,000	$490,000	1.47	$231,000

EVALUATION AND TRADEOFF ANALYSIS

This plan provides the least amount of harbor protection; however, it protects a larger amount of shorefront property on the easterly shore, including the U.S. Coast Guard pier. The mathematical model indicates that this plan has the best flushing patterns.

COST APPORTIONMENT

The cost apportionment is based on the ratio of general and local benefits to the overall benefits and is as follows:

	3-1/4%	7-5/8%
Federal (General)		
Corps of Engineers 65%/66%	$3,954,500	$4,015,500
U.S. Coast Guard	6,500	6,500
Total Federal	$3,961,000	$4,022,000
Non-Federal (Local)		
Cash Contribution 35%/34%	$2,130,000	$2,069,000
Total Non-Federal	$2,130,000	$2,069,000
TOTAL	$6,091,000	$6,091,000

PUBLIC VIEWS

Views of Federal Agencies. The U.S. Fish & Wildlife Service recommends that the 5.0 acres of quahaugs be transplanted away from under the proposed breakwater, prior to construction. The U.S. Coast Guard requested a minimum of a 300-foot width between the pier and breakwater, but the 400-foot width provides better flushing. The National Marine Fisheries Service recommended that current studies be made.

Views of Non-Federal Agencies and Others. The Rhode Island Department of Environmental Management favors Plan B over the other breakwater plans. Bristol officials and others at the public meeting favor Plan B.

PLAN C

PLAN DESCRIPTION

This plan is a double breakwater system. It combines Plan B with a 700-foot breakwater extending from the west shore. The two-breakwater configuration would be a combined total of 2,400 feet.

IMPACT ASSESSMENT

Breakwater Impacts. The alignment would protect both shores as well as the Bristol Yacht Club, Bristol Marine and the Coast Guard pier. About 6 acres of bottom shellfish habitat would be destroyed. This plan allows a higher concentration of water mass to remain in the upper harbor and indicates less flushing than the other two plans.

Navigation Impacts. A slightly off-center 1,000-foot opening would remain for navigation use, allowing for currents. This plan would protect 150 acres of waterway and 1,050 moorings.

Economic Impacts. The estimated final cost of Plan C is $8,263,000. The complete analysis of costs and benefits is shown in Appendix F. A summary of the analysis is as follows:

PLAN - C

Rate	Annual Benefits	Annual Costs	B.C.R.	Net Benefits
3-1/4%	$1,004,000	$355,000	2.83	$649,000
7-5/8%	$854,000	$665,000	1.28	$189,000

EVALUATION AND TRADEOFF ANALYSIS

This plan protects the largest amount of waterway and shoreline; however, it has the worst flushing patterns and would probably be detrimental to the biota and water quality.

COST APPORTIONMENT

The cost apportionment is based on the ratio of general and local benefits to the overall benefits and is as follows:

	3 1/4%	7 5/8%
Federal (General)		
Corps of Engineers 62%/64%	$5,117,500	$5,282,500
U.S. Coast Guard	9,500	9,500
Total Federal	$5,127,000	$5,292,000
Non-Federal (Local)		
Cash Contribution 38%/36%	$3,136,000	$2,971,000
Total Non-Federal	$3,136,000	$2,971,000
TOTAL	$8,263,000	$8,263,000

PUBLIC VIEWS

Views of Federal Interests. The U.S. Fish and Wildlife Service recommended the transplanting of about 6 acres of quahaugs from under the breakwaters, prior to construction. The National Marine Fisheries Service recommended that current studies be made.

Views of Non-Federal Interests and Others. The Rhode Island Department of Environmental Management favors a single breakwater, as do town officials and others.

COMPARISON OF DETAILED PLANS

In general, the three rock breakwater plans at the head of the harbor are similar, in that they each protect the harbor and shoreline from storm waves originating in Narragansett Bay and provide the opportunities for environmental quality enhancement, navigational improvements and economic development.

In essence the breakwaters vary in location, alignment and degree of protection provided. In comparing the detailed plans, a trade-off must be made between maximization of protection of the recreational and potential commercial fleets and the risk of reducing natural flushing action of the harbor. The degree to which each alternative protects the boats in the harbor and the shoreline and the impacts on pollution and flushing are what differentiate the alternatives.

Plans A and B have a minimal impact on the tidal currents and tide levels and Plan C has the greatest impact. The absolute significance of any increase in tidal currents caused by any breakwater depends on the resultant degree of pollution and flushing action in the harbor. Mathematical analysis indicates that Plan B would be the least detrimental to the flushing action of Bristol Harbor.

Although Plans A and C protect more waterway in the harbor than Plan B, the difference between A and B is small and Plan C costs more than Plan B.

The degree of protection afforded the shoreline is greatest with Plan C, and the least with Plan A. Plan B appears to be a reasonable trade-off among the alternatives considered.

During severe winters ice forms in the upper harbor, however, the breakwaters will not significantly affect the ice problem because of the length and shape of the natural harbor. Plan B, with the largest overall openings, will have the least impact when the ice begins to break up and move out.

COST COMPARISON

All three breakwater plans require similar methods of construction, but vary in magnitude. Plan A would be 1,600 feet long; Plan B, 1,700 feet long; and Plan C, 2,400 feet long. Construction could be carried out from temporary land approaches or from crane-mounted barges. Costs are estimated for barge-mounted cranes and deposition of dredged materials at the Brenton Reef Ocean Dump Site in Rhode Island Sound, just off Newport, Rhode Island. Comparisons of first and annual costs are shown in Tables 3 and 4.

TABLE 3
COMPARISON OF PROJECT COSTS

	PLAN A	PLAN B	PLAN C
Construction Costs	$4,385,000	$4,527,000	$6,141,300
Contingencies	876,500	905,500	1,228,200
Total Construction Costs	$5,261,500	$5,432,500	$7,369,500
Engineering & Design	263,000	272,000	368,500
Supervision & Administration	368,500	380,000	515,500
Total Project Costs	$5,893,000	$6,084,500	$8,253,500
Navigation Aids	6,000	6,500	9,500
Total First Costs	$5,899,000	$6,091,000	$8,263,000

TABLE 4
COMPARISON OF ANNUAL COSTS

PLAN A	3 1/4%	7 5/8%
Interest & Amortization	$240,300	$461,300
Annual Maintenance	$ 12,700	$ 12,700
Total Annual Costs	$253,000	$474,000
PLAN B		
Interest & Administration	$247,850	$476,850
Annual Maintenance	$ 13,150	$ 13,150
Total Annual Costs	$261,000	$490,000
PLAN C		
Interest & Amortization	$336,500	$646,500
Annual Maintenance	$ 18,500	$ 18,500
Total Annual Costs	$355,000	$665,000

BENEFIT COMPARISON

Each of the detailed breakwater plans would provide sufficient protection to the harbor to prevent damages to the existing boating fleets and the shoreline. In addition, they would encourage new boats to moor in the harbor and provide the opportunity for economic development within the harbor area. A detailed discussion of the anticipated benefits is shown in Appendix F. A summary of the annual benefits of all three detailed breakwater plans is shown in Table 5. Net benefits are shown in Table 6.

TABLE 5
ANNUAL BENEFITS

	3 1/4%	7 5/8%
PLAN A		
Recreational	$572,000	$509,000
Commercial	102,000	102,000
Damages Prevented	55,000	55,000
Total Annual Benefits	$729,000	$666,000
PLAN B		
Recreational	$541,000	$489,000
Commercial	153,000	153,000
Damages Prevented	78,000	78,000
Total Annual Benefits	$772,000	$720,000
PLAN C		
Recreational	$765,000	$615,000
Commercial	153,000	153,000
Damages Prevented	$ 86,000	$ 86,000
Total Annual Benefits	$1,004,000	$854,000

TABLE 6
NET BENEFITS

	3 1/4%	7 5/8%
PLAN A		
Annual Benefits	$729,000	$666,000
Annual Costs	$253,000	$474,000
Net Benefits	$476,000	$192,000
B/C Ratio	2.88	1.41
PLAN B		
Annual Benefits	$772,000	$720,000
Annual Costs	$261,000	$490,000
Net Benefits	$511,000	$231,000
B/C Ratio	2.96	1.47
PLAN C		
Annual Benefits	$1,004,000	$854,000
Annual Costs	$ 355,000	$665,000
Net Benefits	$649,000	$189,000
B/C Ratio	2.83	1.28

Plan C has the largest net benefits for 3-1/4% and Plan B has the largest net benefits for 7-5/8%.

The primary environmental concerns associated with the alternative breakwater plans are the disposal options. The State of Rhode Island does not have an authorized ocean disposal site at this time and one may not be available at the time of construction. Other potential sites within Narragansett Bay are at the Prudence Island Historic Dump Site in the East Passage, the Conimi "Cut Point" in-channel" site, Spar Island, Common Fence Point, and Spectacle Cove in Portsmouth. However, use of these sites is still prohibited.

The town of Bristol has authorized the disposal of approximately 40,000 cubic yards of dredged material in their sanitary landfill area. However, the site would be the least environmentally acceptable site at this time due to the need to transport the dredged material by trucks through the city streets.

Other concerns are changes in the tidal prism water quality and adequate harbor flushing of existing pollutants.

ENVIRONMENTAL COMPARISON

The same types of environmental impacts would result from all three breakwater plans, but the least environmental impact would result from Plan B. A detailed comparison is shown in the Environmental Assesments starting on page 35.

COMPARISON SUMMARY

A comparison of the three detailed plans is shown in the Summary of System of Accounts in Table 7. By displaying the significant beneficial and adverse impacts, the system is intended to assist tradeoff analysis and final decisionmaking. The complete System of Accounts is shown in Appendix B.

TABLE 7
SUMMARY OF SYSTEM OF ACCOUNTS - 3-1/4%

ACCOUNT	PLAN A	PLAN B	PLAN C
A. Plan Description	1600-Foot Rock Breakwaters	1700-Foot Rock Breakwaters	2400-Foot Rock Breakwaters
B. Impact Assessment			
1. National Economic Development			
a. First Cost	$5,899,000	$6,091,000	$8,263,000
b. Annual Benefits	$729,000	$772,000	$1,004,000
c. Annual Costs	$253,000	$261,000	$ 355,000
d. B/C Ratio	2.88	2.96	2.83
e. Net Benefits	$476,000	$511,000	$649,000
2. Environmental Quality			
a. Tidal Currents	Minimal	Minimal	Slight Increase
b. Dredging Impacts on Water Quality	Temporary	Temporary	Temporary
c. Flushing Patterns	Adequate	Best	Worse
d. Shoreline Protection	Least	Better	Best
e. Aesthetics	Favorable	Favorable	Favorable
C. Plan Evaluation			
1. Achieves Planning Objectives			
a. Protects Boats and Shoreline	Yes	Yes	Yes
b. Provides Opportunity for Expansion	Yes	Yes	Yes
c. Improves Navigation	Yes	Yes	Yes
D. Public Response			
1. General Acceptance	Yes	Yes	Yes
E. Implementation Responsibility			
1. Federal (Incls U.S.C.G. 0%)	$3,601,000 (61%)	$3,961,000 (65%)	$5,127,000 (62%)
2. Non-Federal	$2,298,000 (39%)	$2,130,000 (35%)	$3,136,000 (38%)
First Costs	$5,899,000 (100%)	$6,091,000 (100%)	$8,263,000 (100%)

R 2/82

RATIONALE FOR DESIGNATION OF NED PLAN

An NED (National Economic Development) plan addresses the planning objectives in such a way as to maximize net economic benefits. Net economic benefits are maximized when plan scale is optimized and the plan is efficient. Scale is optimized when benefits of each increment of the plan at least equal economic cost, and a plan is efficient when the outputs of the plan are achieved in a least cost manner.

All three detailed plans yield economic benefits and satisfy the Principles and Standards requirements for a NED plan. However, using the mandated interest rate of 3 1/4 percent, Plan C has the largest net benefits and it is designated as the NED plan.

RATIONALE FOR DESIGNATION OF EQ PLAN

An EQ (Environmental Quality) plan is the alternative which addresses the planning objectives in such a way as to make the most significant contribution to the management, conservation, preservation, creation, restoration or improvement of the quality of natural and cultural resources and ecological systems.

All three considered detailed plans have positive effects on the environment as well as enhancement of commercial and recreational boating and navigational safety.

Mathematical modeling indicated that Plan B was the least detrimental to the natural flushing of the harbor. Plan B also makes the best contributions to the overall environmental objectives and is therefore designated as the EQ Plan.

RECOMMENDED PLAN

The recommended alternative is Plan B. It would provide a 1,700 linear-foot offshore rock breakwater just south of the Coast Guard pier, and a 1600-foot wide access for navigation on the westerly side of the harbor. It would protect the existing and future recreational and commercial fleets, the Coast Guard pier and the commercial/industrial area along the east shoreline, as well as enhance future development of the harbor. Plan B is shown on Plate 4.

The estimated cost of construction for Plan B is $6,091,000. Annual benefits resulting from the plan of improvement would be $772,000 and the annual charges would be $261,000, yielding a favorable benefit cost ratio of 2.96 to 1.0.

TABLE 2
BRISTOL HARBOR
ELUTRIATE TEST RESULTS

Results of tests performed on: (1) the standard elutriate resulting from the "shake test" using 1 part sediment from various sampling locations with 4 parts water from each sampling location and (2) the virgin water from each sampling location are as follows:

Test Property	Dredge Site Water EW-2-81	Standard Elutriate Designation GE-2-81, EW-2-81 Surface R1 **	R2	R3	Dredge Site Water EW-3-81	Standard Elutriate Designation GE-3-81, EW-3-81 Surface R1 **	R2	R3
Nitrite Nitrogen(N), ppm	< 0.005	< 0.005	< 0.005	< 0.005	0.005	0.005	0.005	0.005
Nitrate Nitrogen(N), ppm	0.18	0.03	0.07	0.02	0.19	0.15	0.03	0.13
Sulfate(SO_4), ppm	3,000	2,830	2,760	2,790	3,170	2,800	2,800	2,690
Oil & Grease, ppm	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Phosphorus (P)								
Ortho, ppm	0.05	0.02	0.06	0.04	0.06	0.04	0.05	
Total, ppm	0.05	0.02	0.06	0.04	0.07	0.05	0.08	0.05
Mercury (Hg), ppb	0.9	0.5	2.7	0.9	1.6	< 0.5	< 0.5	< 0.5
Lead(Pb), ppm	0.015	0.005	0.015	0.015	0.015	0.015	0.015	
Zinc(Zn), ppm	0.065	0.045	0.045	0.025	0.030	0.030	0.020	0.010
Arsenic(As), ppm	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cadmium(Cd), ppm	0.005	0.015	0.005	0.015	0.020	0.020	0.005	0.010
Chromium(Cr), ppm	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
Copper(Cu), ppm	0.004	0.004	0.003	0.006	0.008	0.004	0.004	0.004
Nickel(Ni), ppm	0.020	0.025	0.030	0.030	0.020	0.030	0.020	0.025
Vanadium(V), ppm	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040	< 0.040
Cadmium, Ionic (Cd^+), ppm	3.1	5.4	1.8	2.1	3.9	2.4	1.8	1.8
Silver, (Ag), ppm	< 0.080	0.080	0.130	0.170	< 0.080	0.080	< 0.080	< 0.080
Ammonia Nitrogen (N), ppm	0.9	0.6	0.6	0.7	35.6	9.5	17.4	8.1
Barium, (Ba), ppm	< 0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.02
Beryllium, (Be), ppm	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Selenium, (Se), ppm	0.10	0.04	0.19	0.08	0.10	0.15	0.02	0.10
Total PCB, ppb					< 0.001	0.013	0.028	0.022
Total DDT, ppb					< 0.001	< 0.001	< 0.001	< 0.001

** R1, R2, R3 - Replicate Determinations

(6) Minimize Turbidity Levels

The proposed dredging and disposal plan will minimize turbidity and suspended materials.

(7) Minimize Degradation of Aesthetics, Recreation and Economic Environment

The dredging and disposal operations, if undertaken, will be scheduled so as to minimize aesthetic and recreation effects by limiting conflict with recreational boating. The economic effects of the project are positive. (See Sections I and III).

(8) Avoid Degradation of Water Quality

As discussed in Section III no serious or permanent effects to established water quality standards are expected.

(b) CONSIDERATIONS RELATING TO DEGRADATION OF WATER USES AT PROPOSED DISPOSAL SITE

(1) Municipal Water Supply Intakes

There are no intakes in the vicinity of the proposed construction site.

(2) Shellfish

The construction of the breakwater would eliminate approximately 4-5 acres of bottom shellfish habitat. The rock surfaces of the breakwater, however, will afford suitable habitat for the settlement and growth of mussels, the main shellfish beds located on the western side of the harbor will not be altered.

(3) Fisheries

No adverse effects to fisheries will occur.

(4) Wildlife

Disposal of the dredged materials, if at the landfill site will not result in the loss of upland habitat nor disturbance to wildlife.

(5) Recreation Activities

Fall or winter scheduling of dredging and disposal limits conflict with recreational boating activities and spawning of shellfish.

(6) Threatened and Endangered Species

No threatened or endangered species have been reported at the Bristol Harbor Site.

(7) Benthic Life

Temporary losses to the benthic community during dredging/disposal and breakwater construction will be rapidly made up through recolonization.

(8) Wetlands

No disposal in wetlands is proposed.

(9) Submerged Vegetation

Disposal at the sites being considered will not adversely affect aquatic vegetation.

5. Determinations and Findings

a. An ecological evaluation as required by Section 404(b)(1) of the Clean Water Act has been made following the evaluation guidance in 40 CFR 230.4, in conjunction with the evaluation considerations in 40 CFR 230.5. Appropriate measures have been identified and incorporated in the proposed plan to minimize adverse effects on the aquatic environment as a result of the discharge. Consideration has been given to the need of the proposed activity, the availability of alternative sites and methods of disposal that are less damaging to the environment, and such water quality standards as are appropriate and applicable by law. Impact on a minor wetland at the site would be unavoidable and approximately 4-5 acres of subtidal habitat would be eliminated. Reestablishment would occur on the breakwaters subtidal areas. Adverse impacts to the total marine ecosystem would not be significant. Activities associated with the proposed fill would be water oriented and water dependent. Construction during critical spawning periods and peak recreational boating would be avoided to minimize these impacts. A Public Notice with respect to the 404 Evaluation will be issued accompanying this decrement. Based on information presented in the 404 Evaluation and Environmental Assessment, I find that the project will not result in unacceptable impacts to the environment.

C. E. Edgar III

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

FINDING OF NO SIGNIFICANT IMPACT

The recommended navigation improvement alternative at Bristol Harbor consists of a 1700-L.F. offshore dog-leg rock breakwater, located just south of the U. S. Coast Guard Pier, and a 1600-foot wide navigation opening on the west side of the harbor. Alternative methods of constructing the project include displacement of bottom materials "by end-dumping"; dredging of 25,000 to 40,000 cy of bottom material and its replacement with sandfill, ocean or land disposal; or placement of a 6-foot thick sand blanket under the outer section of breakwater.

The proposed project would provide Bristol Harbor with badly needed protection of Bristol Harbor from southerly storm waves and enhance future economic development.

The determination to prepare an Environmental Assessment, as opposed to an Environmental Impact Statement, was based on the following considerations:

- The Mathematical Hydrodynamic and Dispersion Prediction Model of the proposed breakwaters in Bristol Harbor indicated dispersion patterns similar to those without the breakwater.

- An analysis of the bottom material indicates that it would be suitable for either ocean or land disposal, if dredging is required.

- Construction of the rock breakwater would mitigate the removal of bottom shellfish habitat by providing hard surfaces for the attachment of various epifaunal invertebrates and habitat for fin fish, lobsters and mussel production.

- Environmental and social impacts would be minimal.

Coordination and consultation with appropriate Federal and State agencies insured that their concerns and recommendations were identified to the Corps so that they could be addressed during construction planning.

DATE

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

CONCLUSIONS

The alternative plans and all pertinent data concerning navigation and related improvements in Bristol Harbor have been reviewed and evaluated in the overall public interest.

It is concluded that there is a need to provide protection to Bristol Harbor from southerly storm waves originating in Narragansett Bay and an offshore rock breakwater designated as Plan B would best meet the planning objectives, the present and future needs of local interests, and enhance future economic development within Bristol Harbor as well.

The economic analysis of the selected plan, PLAN B, indicates a 65% Federal cost and a 35% local cost, however, the cost sharing percentages in the authorizing legistation dated 13 August 1968, mandated the cost sharing percentages to 64% Federal and 36% local. The interest rate was subsequently fixed at 3-1/4 percent. Therefore, the cost allocation is set at the mandated percentages and the Corps of Engineers cost would be $3,894,500 (64%); the U.S. Coast Guard cost would be $6,500; and the local cost would be $2,190,000 (36%). (See Table XV on page F-22 in AppendixF).

RECOMMENDATIONS

It is recommended that the rock breakwater authorized by Public Law 90-483, 90th Congress S 3710 on August 13, 1968, Section 101 of the 1968 River and Harbor Act, in Bristol Rhode Island, be constructed in accordance with the modifications described in this report, and designated as Plan B.

The recommendation is made subject to the conditions that non-Federal interests will:

a. Make a cash contribution of 36 percent of the first cost of the construction of the breakwater, said contribution currently estimated at $2,190,000, and subject to final adjustment after actual costs have been determined.

b. Provide, without cost to the United States, all lands, easements, rights of way necessary for the construction and subsequence maintenance of the project when and as required, including suitable dredged material disposal areas with necessary retaining dikes, bulkheads and/or embankments if required. Rights of way should include access for a contractor and his equipment to construct the breakwater from land, if he exercises the option to do so.

c. Accomplish without cost to the United States, all alterations and/or relocations in sewer, water supply, drainage and other utility facilities, as required for the construction of the overall project.

d. Hold and save the United States free from damages that may result from construction and subsequent maintenance of the project.

e. Provide and maintain berths, floats, piers, and/or similar marina and mooring facilities as needed for transient and local vessels as well as necessary access roads, parking areas and other needed public use shore facilities open and available to all on equal terms. Only minimum, basic facilities and service are required as part of this project. The actual scope or extent of facilities and services provided over and above the required minimum is a matter of local decision. The manner of financing such facilities and services is a non-Federal responsiblity.

f. Establish regulatons prohibitng the discharge of untreated sewage, garbage, and other pollutants in the waters of the harbor, such regulations shall be in accordance with applicable laws or regulations of Federal, State and local authorities responsible for pollution prevention and control.

C. E. EDGAR, III
Colonel, Corps of Engineers
Division Engineer

ACKNOWLEDGEMENT AND IDENTIFICATION OF PERSONNEL

This report was prepared under the general supervision of the following New England Division Personnel:

Colonel Max B. Scheider, Division Engineer (Retired Dec. 1980)
Colonel C. E. Edgar, III, Commander and Division Engineer
Joseph L. Ignazio, Chief, Planning Division
Donald Martin, Chief, Coastal Development Branch

The study was managed by Steven Onysko, P.E., Project Manager in the Coastal Development Branch. The Environmental Assessment was prepared by Gilbert L. Chase Jr., of the Impact Analysis Branch and the Economic Analysis was prepared by John J. Barry of the Economic and Social Analysis Section. Engineering analyses was performed by Anthony Mancini of the Coastal Engineering and Survey Section.

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R.I. Division of Marine Fisheries.
R.I. Division of Environmental Management.
R.I. Coastal Resources Management Council.
Mrs. Sarah Amaral, Bristol Town Administrator
Gerhard Oswald, Bristol Town Planner
Joseph Cabral, Bristol Harbormaster
Bristol Town Council
Alan Guimond, Stonington Seafood Corporation
Arthur Beauregard, Chairman, Waterfront Improvement Committee.

APPENDIX B

FORMULATION, ASSESSMENT, AND EVALUATION OF DETAILED PLANS

SECTION A

FORMULATION AND EVALUATION CRITERIA

The formulation of a plan of improvement for Bristol Harbor has followed the procedures of the Water Resources Council Principles and Standards. Local needs and objectives were identified and project-specific planning and opportunity statements were established. These planning and opportunity statements were considered in the formulation of detailed plans, as were the national objectives of National Economic Development (NED) and Environmental Quality (EQ).

Detailed technical, economic and environmental criteria were applied in the formulation and evaluation of the alternative plans. These criteria reflect quantitative measures of the plan performance in relation to the national and local planning objectives and planning constraints. These criteria, which are described below, are utilized in the System of Accounts to evaluate the three alternative detailed plans.

TECHNICAL CRITERIA

The technical criteria are as follows:

- The selected plan should provide the maximum economical amount of protection from the design storm wave, from southerly quadrants.

- The selected plan should reduce the design wave to 1 to 2 feet, to provide an adequate safe anchorage for the number of boats expected to use the harbor.

ECONOMIC CRITERIA

The economic criterion is as follows:

- Maximize net benefits (project benefits minus project costs).

ENVIRONMENTAL CRITERIA

The environmental criteria are as follows:

- Minimize volume of dredge material in order to reduce problems relating to disposal of dredged material.

- Minimize and mitigate removal of bottom shellfish habitat.

SOCIAL AND CULTURAL CRITERIA

The social and cultural criteria are as follows:

- Maximize safety and ease of navigation for all craft utilizing the harbor.

- Maximize the cultural and aesthetic value to the harbor and any structures constructed.

- Contribute to the economic development of the Bristol Harbor area.

SECTION C

COMPARISON OF DETAILED PLANS

In comparing the proposed detailed plans it is noted that many do not fully comply with standards set forth under Principles and Standards. Therefore a tradeoff analysis was performed to determine the most economical plan of improvement for further study. It was determined that the breakwater plans were the most practical and economical and had the least impact on the environment.

Plan A - This originally authorized plan satisfies the planning objectives and provides protection to the harbor, but does not provide protection to the U.S. Coast Guard pier or a portion of the commercial/-industrial shorefront. This plan is the least expensive and provides minimum benefits of the three plans. The water quality impacts for all breakwater plans will be the same.

Plan B - This dogleg breakwater plan would provide protection to the harbor, U.S. Coast Guard pier and the commercial/industrial area, unlike Plan A. The benefits for this plan are greater than for Plan A but less than Plan C. The cost is slightly higher than Plan A but the net benefits are greater.

Plan C - This plan is an addition to Plan B and will provide harbor protection and protect the U.S. Coast Guard pier and the commercial/industrial area. It will also provide protection to the Bristol Yacht Club and Marine Boat Yard. This plan is the most expensive of the three plans and provides maximum benefits of all the breakwater plans. It also has the lowest benefit-to-cost ratio when compared to Plans A and B.

SYSTEM OF ACCOUNTS

The System of Accounts is a summary evaluation required by the Principles and Standards. The System of Accounts provides in a concise format an evaluation of the alternative plans in terms of the national objectives of National Economic Development (NED), Environmental Quality (EQ), and the national accounts of Social Well-Being (SWB) and Regional Development (RD). It also demonstrates plan performance in terms of the planning objectives and constraints; the technical, economic, and other criteria; and other measures such as plan acceptability.

The System of Accounts is shown in Table B-1. The summary assessments indicate that the plans have varying responses to the different national objectives and accounts. In evaluating all impacts considered, Plan B is shown to be the most favorable option considered.

TABLE B-1

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
A. PLAN DESCRIPTION	1600-ft. offshore rock breakwater beginning 400´ west of the Coast Guard Pier & extending in a northwest direction.	1700-ft. offshore, dog-leg rock break-water, beginning 400´ from the east shore & 300´ south of the coast guard pier, then extending north-westerly.	1700 ft. offshore, dog-leg rock break-water, beginning 400´ from the east shore & 300´ south of the coast guard pier, and an additional 700 ft. rock breakwater extending from the westerly shore in an easterly direction.
B. IMPACT ASSESSMENT			
NATIONAL ECONOMIC DEVELOPMENT			
First Cost	$5,899,000	$6,091,000	$8,263,000
Average Annual Benefits	$729,000	$772,000	$1,040,000
Average Annual Costs	$253,000	$261,000	$355,000
New Benefits	$474,000	$511,000	$649,000
Benefit-Cost Ratio	2.88	2.96	2.83

TABLE B-1 (Cont'd)

SYSTEM OF ACCOUNTS

ITEM	PLAN A	PLAN B	PLAN C
ACHIEVES OBJECTIVES			
Protects Boats	Yes	Yes	Yes
Protects Shoreline	Yes	Yes	Yes
Provides Opportunity for Expansion	Yes	Yes	Yes
Improves Navigation Safety	Yes	Yes	Yes
D. PUBLIC RESPONSE			
GENERAL ACCEPTANCE			
Plan is Acceptable by Town Officials	Yes	Preferred	Yes
Plan is Acceptable to Private Concerns	Yes	Preferred	Yes
Plan Compliments Redevelopment Plans of the Town	Yes	Preferred	Yes
E. IMPLEMENTATION RESPONSIBILITIES			
COST SHARING			
Federal (Incls U.S.C.G., 0%)	$3,601,000 (61%)	$3,961,000 (65%)	$5,127,000 (62%)
Non-Federal	$2,298,000 (39%)	$2,130,000 (35%)	$3,136,000 (38%)
First Costs	$5,899,000 (100%)	$6,091,000 (100%)	$8,263,000 (100%)

APPENDIX D

ENGINEERING INVESTIGATION, DESIGN AND COST ESTIMATES

SECTION A

DESIGN CRITERIA

INTRODUCTION

The principal problem in Bristol Harbor is inadequate protection of the existing and prospective recreational and commercial boating fleets, as well as shoreline structures, from storm waves originating in Narragansett Bay.

Design criteria was established to determine the optimum siting, wave heights, design of rock sizes, wave refraction and diffraction, and tidal current patterns for the alternative rock breakwaters in Bristol Harbor, as well as other pertinent data, described below.

TIDES

The tides in Bristol Harbor are semi-diurnal. Mean and Spring tide ranges are 4.0 and 5.0 feet respectively.

TIDAL CURRENTS

Tidal currents in Bristol Harbor, as given by the National Ocean Survey "Tidal Current Tables for 1981, Atlantic Coast of North America," are too weak and variable to be predicted.

PREVAILING WINDS

The maximum gust of wind recorded in New England is 186 mph and the maximum sustained 5-minute velocity is 121 mph, which were recorded in the September 1938 hurricane at the Blue Hills Observatory in Milton, Massachusetts, about 35 miles northeast of Bristol. The summer seasonal prevaling winds affecting Bristol harbor are from the southeast and southwest quadrant and can obtain speeds up to a gale force of 50 mph.

DESIGN TIDE

The design tide is the highest tide which is estimated to occur in the project area on the average of once per year. The tide in Bristol Harbor can be expected to reach one foot over a mean spring tide and the height of 6.0 feet (5.0 MST +1.0′ surge) was selected as the design still water level.

DESIGN WAVE

The height of the design wave is the significant wave (highest one-third of the waves and period in a wave train) which could be expected to reach the proposed structure at the time of a design tide. The wave was determined from the effective fetch of 3-3/4 miles from the SSW direction and 2.85 miles from the SSE direction, based on the irregular shoreline method and an average water depth of 25 feet, and is 4.0 feet, at design stillwater level. The significant wave period is 3.5 seconds, for a 50 mph wind speed.

BREAKWATER DESIGN

Based on experience for rubble mound rock breakwaters placed in similar environments, minimum side slopes of 1.0 vertical on 1.5 horizontal were selected as being the most effective and economical, for both sides of the breakwater.

It has been assumed that stone will be obtained from a commercial quarry in Tiverton, Rhode Island. The quarry is located approximately 6 nautical miles southeast of the project site and has access to loading facilities located on the Sakonnet River. Stone frome this source is granite weighing 165 pounds per cubic foot. The breakwater design is based on the use of rough armor stone, individually placed, in two layers. The average weights of armor stone have been determined from the U.S. Army Coastal Engineering Research Center (CERC) guide equation shown in the "Shore

BREAKWATER DESIGN

Based on experience for rubble mound rock breakwaters placed in similar environments, minimum side slopes of 1.0 vertical on 1.5 horizontal were selected as being the most effective and economical, for both sides of the breakwater.

Protection Manual" and is as follows:

$$W = \frac{W_r H^3}{K_d (S_r - 1)^3 \cot \theta}$$

Where:

- W = Weight of armor stone in pounds
- Wr = Unit weight of armor stone in lbs/ft^3
- H = Design wave height at the structure in feet
- Sr = Specific gravity of armor stone relative to the water at the structure (Sr=Wr/Ww)
- Ww = Unit weight of sea water = 64.0 lbs/ft^3
- 0 = Angle of structure slope measured from horizontal in degrees
- Kd = Stability coefficient that varies primarily with the shape of the armor stone, roughness, and degree of interlocking obtained in placement.

The typical cross section of the breakwater and maximum and minimum weights of the armor and underlayer stone are shown on Plate D-1.

TABLE D-1
SUMMARY OF COST ESTIMATES

PLAN A (Authorized Alignment)	
Excavation, including disposal 40,000 c.y. @ $8/c.y.	$ 320,000
Coverstone, Type A, furnished and placed 24,960 tons @ $25.30/ton	631,500
Coverstone, Type B, furnished and placed 13,760 tons @ $25.30/ton	348,100
Bedding Stone, furnished and placed 17,760 tons @ 24.30/ton	431,600
Core stone, furnished and placed 145,440 tons @ $18.25/ton	2,654,300
Subtotal	$4,385,500
Contingencies, 20%	876,500
Total Construction Cost	$5,262,000
Engineering & Design, 5%	263,000
Supervision & Administration, 7%	368,000
Subtotal	$5,893,000
U.S. Coast Guard, Aids to Navigation	6,000
Total First Cost	$5,899,000
PLAN B (Selected Alignment)	
Excavation, including disposal 42,000 c.y. $ $8/c.y.	$ 336,000
Coverstone, Type A, furnished and placed 26,100 tons @ $25.30/ton	660,300
Coverstone, Type B, furnished and placed 14,320 tons @ $25.30/ton	362,300
Bedding stone, furnished and placed 18,510 tons @ $24.30/ton	449,800
Core stone, furnished and placed 148,970 tons @ $18.25/ton	2,718,700
Subtotal	$4,527,000
Contingencies, 20%	905,500
Total Construction Cost	$5,432,000
Engineering & Design, 5%	272,000
Supervision & Administration, 7%	380,000
Subtotal	$6,084,500
U.S. Coast Guard, Aids to Navigation	6,500
Total First Cost	$6,091,000

PLAN C (Alternative Alignment)

Excavation, including disposal 59,260 c.y. @ $8/c.y.	$ 474,100
Coverstone, Type A, furnished and placed 36,235 tons @ $25.30/ton	916,700
Coverstone, Type B, furnished and placed 19,834 tons @ $25.30/ton	501,800
Bedding Stone, furnished and placed 25,686 tons @ $24.30/ton	624,200
Core stone, furnished and placed 198,602 tons @ $18.25/ton	3,624,500
Subtotal	$6,141,300
Contingencies, 20%	1,228,200
Total Construction Cost	$7,369,500
Engineering & Design, 5%	368,500
Supervision & Administration, 7%	515,500
Subtotal	$8,253,500
U.S. Coast Guard, Aids to Navigation	9,500
Total First Cost	$8,263,000

PROJECT MAINTENANCE COSTS

The breakwaters would require periodic maintenance after construction is completed, as it can be expected that waves greater than the design wave could occur during severe storms and incur damages to the armor stone. It is estimated that the quantity of armor stone needing annual maintenance would be about one percent of the total quantity of armor stone required to construct the breakwater. Annual maintenance costs are shown in Appendix F.

APPENDIX F
ECONOMIC ANALYSIS

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LIST OF TABLES (Cont.)

respective capacities are reached. The composition of the future expansion is weighed more heavily toward sailboats to reflect the increasing preference for sail over powercraft.

A summary of the anticipated growth pattern for each of the three plans is shown in Table I below.

TABLE I
Anticipated Growth Pattern

PLAN	Existing Fleet: Unprotected By Project	Existing Fleet: Protected By Project	Fleet Growth (Protected by Project): Immediate	Fleet Growth (Protected by Project): Future	Time to Reach Capacity Years	Total Number of Boats
A	-	250	150	340	17	740
B	-	250	150	305	15	705
C	125	125	150	775	39	1,175

D. Recreational Boating Benefits

Recreational boating benefits are defined as values equal to the net return on the depreciated investment on the boat, after expenses, that owners would receive if their boats were let out for hire. The net return varies according to the type of boat and its size.

For the existing fleet of 250 boats, only 80 percent of the ideal benefits are assumed as presently being realized. This figure is taken to be uniform. Benefit computations are based on the following assumptions:

EXISTING FLEET (PLAN A) - The existing fleet (250 boats) will average 10 percent more usage, thus increasing usage from 80 percent of ideal to 90 percent of ideal. This assumption recognizes that few if any of the existing boats will lie in the fully protected area. Despite this fact, attenuation of spurious waves will occur on both sides of the breakwater. As a result, boaters will be able to row to and from their boats by dinghy in weather that would be inhibiting without the breakwater.

EXISTING FLEET (PLAN B) - The same assumptions hold as in Plan A.

EXISTING FLEET (PLAN C) - Half of the existing fleet (125 boats) will not be in the area fully protected by the improvement. Nevertheless, the attenuation effect on wave action will permit the usage level for these boats to reach 95 percent of ideal. The other half of the present fleet will lie in fully protected areas, thus attaining usage levels at 100 percent of ideal.

NEW MOORINGS (PLANS A, B & C) - All fleet increases, both immediate and future, will moor in fully protected areas, thus generating usage levels at 100 percent of ideal. Few, if any of the existing fleet are expected to transfer to fully protected area. This expected reluctance to transfer is based on:

(1) The desire to remain in close proximity to the yacht club
(2) The expense and bother involved in moving their mooring
(3) The likelihood that some improvement to the existing mooring location will occur even though it would not be in a fully protected zone.

A transient fleet was not included in the benefit analysis due to its small number and the relatively short stays anticipated in Bristol. Yacht club officials estimate a transient fleet of 175 to 200 boats, staying an averaging of three days each. Multiplying the number of boats by the average stay results in the number of boat days per year. Dividing this by the number of days in the boating season at Bristol results in a transient fleet average approximately four boats per day. Because any attempt at defining the class and size of the transients would be purely speculative and relatively insignificant in the final analysis, no benefit is evaluated.

Many of the boats in Bristol are large inboards and cruising sailboats which spend as much as 25 percent of their time away from port. Therefore the "on cruise" estimates in Table I thru VI are taken to be percentage of the season the boats are out of the harbor.

Tables II and III show the breakdown of the existing fleet and the anticipated benefits accruing to the breakwater after construction of Plans A, B, or C (see Pages F-5 and F-6). Table IV shows the anticipated growth and benefits of the expanded fleet immediately after construction of Plans A, B, or C (see Page F-7). Tables V, VI and VII show vessel composition and benefits for future expansion under Plans A, B and C, respectively, (see Pages F-8, F-9, F-10).

The recreational boating benefits were originally prepared using October 1980 boat values, but were subsequent updated by 9.75 percent to reflect July 1981 price levels and are shown in Table XX, Estimated Annual Benefits (see Page F-16).

E. Commerical Fishing Benefits

BRISTOL AS A COMMERICAL FISHING PORT

INSHORE FISHERY

Commerical fishing in Bristol Harbor and vicinity is presently limited to shellfishing of quahaugs, mussels and Conch (snails).

The fluctuating nature of the Conch market indicates that there is a limited benefit to that fishery. Conversations with one of the largest Conch dealers in the State, indicates that public acceptance of that shellfish has not increased appreciably over the years and probably will not in the near future.

As for quahaugging, there does not seem to be any predictable relationships between the proposed breakwater plans and this industry's future. Rather, the quahaug fishery is sensitive to pollution, the general state of the economy and, of course, the resource limit.

OFFSHORE FISHERY

Some commercial fishermen do not consider Bristol to be an attractive location for an offshore fishing port, due primarily to the open exposure of the harbor to southerly storm waves from Narragansett bay and the distance from the fishing grounds. Some also feel that Rhode Island has a surplus of potential fishing ports, although it is admitted that most of them were not properly developed for commercial offshore fishing operations and are already overcrowded. On the other hand, Bristol Harbor has adequate water depth and potential berthing space, as well as available land that could support offshore facilities.

Bristol Harbor would certainly be improved with the construction of a breakwater, which could act as a stimulus for building new docks and shore facilities. Because of shifting price structures, it is not possible to predict the rate Bristol would develop as a commercial port, as the trend has been to move from port to port on a seasonal basis, due to shifting prices, to such ports as New Bedford, Stonington, Montauck Point, Newport, Fall River, Point Judith, etc. However, these ports are becoming more and more over crowded with their own fleets, and transient boats cannot find berthing spaces for minor repairs, periodic maintenance, reprovisioning, weather delays, or use the locations as a home port.

Bristol Harbor represents a potential future berthing and/or landing port for Ocean (Mahogony) Quahaugs, as well as a home port for future vessels engaging in the offshore under utilized fish species.

The Town Officials, Chamber of Commerce, commercial and recreational boating interests and the U.S. Coast Guard support the construction of a breakwater for the protection and economic development of the harbor.

STONINGTON SEAFOOD PRODUCTS PROPOSAL

Stonington Seafood Products (SSP) filed a report dated June 1, 1981, with the New England Division, U.S. Army Corps of Engineers indicating their desire to enter into a joint venture (GIFA) with Sweden provided a breakwater is built at Bristol. In essence the report states that if a breakwater is built in Bristol, a fleet of approximately 12-15 idle Gulf Coast shrimpboats will be home ported in Bristol Harbor. As part of the U.S./Swedish joint fishing venture these boats would engage in harvesting hake and delivering the harvest to two Swedish processing vessels deployed in the fishing grounds. The product after initial processing would be frozen and shipped to an eastern European country for completion of processing and distribution through an established marketing system. No fish would actually be landed in Bristol. The Gulf coast shrimpboats would only berth in Bristol Harbor.

The Stonington Seafood proposal does illustrate the type of commercial fishing development that might occur under the with-project condition. Although the construction of breakwater at Bristol does not appear to be a necessary condition for large scale exploitation of the silver hake fishery, it does appear to be a necessary factor for Bristol to complete for an offshore fishing fleet. Granted, the breakwater by itself does not provide a sufficient condition for Bristol to be a fishing port. While a breakwater might well act as a catalyst for attracting a fishing fleet to Bristol, a number of ancilliary services are also required, such as, marketing, offloading faciliites, ice, fuel, ships store, repair facilities, transporation, sewage disposal, water supply, electricity, etc.

An analysis of the Stonington Seafood proposal which includes the incorporation of its probability of being implemented and continuance is shown in the Supplemental Economic Analysis of Estimated Commerical Fishing Bnefits in Appendix G. The final computed benefit of $153,000 is felt to be indicative of the offshore fishery potential at Bristol under the with-project condition for Plans B and C which would give full protection to the proposed fish pier area at the town marina (State Armory). Plan A, however, would only provide protection an estimated two-thirds of the time based on its configuration. Thus, two-thirds of the $153,000 benefit equal to $102,000 is claimed for Plan A.

F. Damage Prevented Benefits

Damage estimates for the recreational fleet were derived from conversations with Bristol Marine, where most repairs in Bristol Harbor are done. Each year, two to three boats are damaged with total damages running approximately $10,000. Since all damages are not reported, but instead are repaired by the owners themselves, the estimate of $10,000 is considered conservative.

The U.S. Coast Guard Pier sustains physical damages during storms and measures are taken to avoid damage to their 180-foot buoy tender and other smaller vessels. When storms arise, the boats are moved to Mt. Hope Bay or Greenwich Cove in E. Greenwich, Rhode Island, where they wait out the storm. Damages to the pier include replacing the timber piles, repairing the concrete deck, granite walls, service utilities, etc. Annual benefits with Plans B or C are estimated to be $18,000.

Damage estimates for large commercial boats were not taken for the purpose of this study. Although several commercial boats (30′ - 40′) are located in the harbor, damage sustained is minimal. When severe storms arise, the boats can be moved to Tiverton Harbor. However, this rarely occurs, hence expenses incurred in moving the boats is considered not to be significant. In addition, several large fishing boats are owned by local wholesalers, Quito′s and Gilberts. However, they now dock at the Fisherman′s Cooperative in Galilee, Point Judith, Rhode Island. A move back to Bristol at this time would not be economically advantageous in view of rising energy costs and the time spent cruising back up to the harbor after the days fishing.

Small commercial shellfishing craft damage estimates were not included in the benefit-cost ratio. Due to the sturdy construction of the boats and the simple gear which is taken home at the end of the day, damages for these small vessels are assumed to be zero. When storms or strong winds do arise these boat owners either pull the boats out of the water or sink the boats without the outboard motors and retrieve them later.

The shore facilities which are damaged are located on the east and west shore of Bristol Harbor. Damage estimates were made by interviewing those affected by storms and obtaining information on historic repairs and maintenance. On the east side, the Prudence Island Ferry has had its sand filled pier washed out several times. Fish wholesalers, Quito and Gilbert, suffer damages annually due to the fact that they lie exposed to the water. Estimated annual damage prevention benefits to the ferry pier, Gilberts and Quitos are $5,000, $3,000 and $7,000, respectively.

Bristol Yacht Club, Bristol Marine and several private docks and piers are located on the west shore of Bristol Harbor. Annual damage prevented to these is estimated at $5,400 with total protection.

In total, there are 15,000 linear feet of shoreline located behind the purposed barriers. Of this amount, 6,400 linear feet is riprap stone. The remainding 8,600 feet is unprotected sand bank with the surface being grassed and landscaped. Plan C would reduce wave action to a minimum amount where it would cause almost no damage. Annual maintenance savings on riprap and bank restoration expenses are estimated to be $37,400. Therefore, the total annual benefit for the west shore structures and shoreline is $43,000 under Plan C, the optimum case. With Plans A and B, however, the maintenance costs saved are expected to be less and are estimated at $30,000 and $35,000, respectively.

Table VII provides a detailed breakdown of the damages which would be prevented by each plan. These damages prevented are considered project benefits. The existing recreational fleet is protected to about the same extent under all plans, therefore it is listed once.

TABLE VIII
Damages Prevented

Recreational Craft	$10,000
Existing Recreational Fleet (2 to 3 boats damaged per year)	
Shore Facilities	
Plan A	
a. Gilbert's Seafood	3,000
b. Quito's Seafood	7,000
c. Prudence Island Ferry Pier	5,000
d. West Shore Structures & Shoreline	30,000
	$45,000
Plan B	
a. Gilbert's Seafood	3,000
b. Quito's Seafood	7,000
c. Prudence Island Ferry Pier	5,000
d. U.S. Coast Guard	18,000
e. West Shore Structures & Shoreline	35,000
	$68,000
Plan C	
a. Gilbert's Seafood	3,000
b. Quito's Seafood	7,000
c. Prudence Island Ferry Pier	5,000
d. U.S. Coast Guard	18,000
e. West Shore Structures & Shoreline	43,000
	$76,000

II. ECONOMIC JUSTIFICATION

A. Estimated First Cost

Estimated first cost for each of the alternative plan have been developed and are presented in Table IX. They are based on July 1981 local construction costs.

TABLE IX
Estimated First Costs

Plan A

Construction and Materials	$4,385,000
Contingencies, 20%	876,000
Total Construction Costs	$5,262,000
Engineering and Design, 5%	263,000
Supervision and Administration, 7%	368,000
Aids to Navigation	6,000
TOTAL FIRST COST	$5,899,000

Plan B

Construction and Materials	$4,527,000
Contingencies, 20%	905,500
Total Construction Costs	$5,432,500
Engineering and Design, 5%	272,000
Supervision and Administration, 7%	380,000
Aids to Navigation	6,500
TOTAL FIRST COST	$6,091,000

Plan C

Construction and Materials	$6,141,300
Contingencies, 20%	1,228,200
Total Construction Costs	$7,369,500
Engineering and Design, 5%	368,500
Supervision and Administration, 7%	515,500
Aids to Navigation	9,500
TOTAL FIRST COST	$8,263,000

B. Estimated Annual Benefits

A summary of the estimated annual benefits for each plan is shown in Table X.

TABLE X
Estimated Annual Benefits

	3-1/4%	7-5/8%
Plan A		
Increased Use of Existing Fleet	$ 34,000	$ 34,000
New Boats (Immediate)	209,000	209,000
New Boats (Future)	329,000	216,000
Reduced Damages to Boats	10,000	10,000
Reduced Damages to Shore Facilities	45,000	45,000
Commercial Fishing	102,000	102,000
TOTAL	$ 729,000	$ 666,000
Plan B		
Increased Use of Existing Fleet	$ 34,000	$ 34,000
New Boats (Immediate)	209,000	209,000
New Boats (Future)	298,000	246,000
Reduced Damages to Boats	10,000	10,000
Reduced Damages to Shore Facilities	68,000	68,000
Commercial Fishing	153,000	153,000
TOTAL	$ 772,000	$ 720,000
Plan C		
Increased Use of Existing Fleet	$ 60,000	$ 60,000
New Boats (Immediate)	209,000	209,000
New Boats (Future)	496,000	346,000
Reduced Damages to Boats	10,000	10,000
Reduced Damages to Shore Facilities	76,000	76,000
Commercial Fishing	153,000	153,000
TOTAL	$1,004,000	$ 854,000

C. Apportionment of Benefits

The economic benefits attributable to the proposed breakwater are summarized according to Type, and are apportioned as local or general, as show in Table XI.

TABLE XI
Apportionment of Benefits

	Local	General	Total
Plan A			
3-1/4%			
Recreational	$286,000	$286,000	$572,000
Commerical	0	102,000	102,000
Damages	0	55,000	55,000
	$286,000	$443,000	$729,000
Percent of Total	39%	61%	100%
7-5/8%			
Recreational	$254,500	$254,500	$509,000
Commerical	0	102,000	102,000
Damages	0	55,000	55,000
	$254,000	$411,500	$666,000
Percent of Total	38%	62%	100%
Plan B			
3-1/4%			
Recreational	$270,500	$270,500	$541,000
Commerical	0	153,000	153,000
Damages	0	78,000	78,000
	$270,500	$501,500	$772,000
Percent of Total	35%	65%	100%
7-5/8%			
Recreational	$244,500	$244,500	$489,000
Commerical	0	153,000	153,000
Damages	0	78,000	78,000
	$244,000	$475,500	$720,000
Percent of Total	34%	66%	100%

TABLE XI (Cont.)
Apportionment of Benefits

	Local	General	Total
Plan C			
3-1/4%			
Recreational	$382,500	$382,500	$ 765,000
Commerical	0	153,000	153,000
Damages	0	86,000	86,000
	$382,500	$621,500	$1,004,000
Percent of Total	38%	62%	100%
7-5/8%			
Recreational	$307,500	$307,500	$ 615,000
Commerical	0	153,000	153,000
Damages	0	86,000	86,000
	$307,500	$546,500	$ 854,000
Percent of Total	36%	64%	100%

D. Estimated Annual Costs

Annual costs for each of these alternatives were calculated at discount rates of 3-1/4, and 7-5/8 percents respectively over a project life of 50 years. The 3-1/4 percent interest rate was mandated at the time of project authorization by Congress. Comparison of annual costs are shown in Table XII.

TABLE XII
Estimated Annual Costs

CFR	3-1/4% (.04073)	7-5/8% (.07823)
Plan A		
Federal		
Corps of Engineers		
I&A (61% x 5,893,000 = 3,594,730 x i)	$146,414	$ 0
(62% x 5,893,000 = 3,653,660 x i)	0	285,826
O&M Armor Stone (.01 x 1,097,170)	11,000	11,000
U.S. Coast Guard		
I&A (61% x 6,000 x i)	300	0
(62% x 6,000 x i)	0	500
O&M (Lump Sum)	1,700	1,700
Non-Federal		
I&A (39% x 5,893,000 = 2,298,270 x i)	93,609	0
(38% x 5,893,000 = 2,239,340 x i)	0	175,184
O&M	0	0
	$253,023	$474,210
Say	$253,000	$474,000

TABLE XII (Cont.)
Estimated Annual Costs

	CFR	3-1/4% (.04073)	7-5/8% (.07823)
Plan B			
Federal			
Corps of Engineers			
I&A (65% x 6,084,500 = 3,954,925 x i)		$161,084	$ 0
(66% x 6,084,500 = 4,015,770 x i)		0	314,154
O&M Armor Stone (.01 x 1,150,341)		11,500	11,500
U.S. Coast Guard			
I&A (6,500 x i)		260	0
(6,500 x i)		0	500
O&M (Lump Sum)		1,650	1,650
Non-Federal			
I&A (35% x 6,084,500 = 2,129,575 x i)		86,738	0
(34% x 6,084,500 = 2,068,730 x i)		0	161,837
O&M		0	0
		$261,232	$489,641
	Say	$261,000	$490,000
Plan C			
Federal			
Corps of Engineers			
I&A (62% x 8,253,500 = 5,117,170 x i)		$208,422	$ 0
(64% x 8,253,500 = 5,282,240 x i)		0	413,230
O&M Armor Stone (.01 x 1,588,770)		16,000	16,000
U.S. Coast Guard			
I&A (9,500 x i)		400	0
(9,500 x i)		0	800
O&M (Lump Sum)		2,500	2,500
Non-Federal			
I&A (38% x 8,253,500 = 3,136,330 x i)		127,743	0
(38% x 8,253,500 = 2,971,260 x i)		0	232,442
O&M		0	0
		$355,065	$664,972
	Say	$355,000	$665,000

E. Benefit-Cost Ratio

For any plan to warrant Federal participation, a benefit-cost ratio of at least unity must be obtained. Dividing the annual benefits by the annual cost results in the benefit-cost ratio. The analysis has been performed for discount rates of 3-1/4 and 7-5/8 percent, respectively. The 3-1/4 percent discount rate is that used for the original project authorization. This was the standard rate used prior to 24 December 1968. The benefit-cost ratios for each plan are shown in Table XIII.

TABLE XIII
Benefit-Cost Ratios

	Rate	Annual Benefits	Annual Costs	Benefit-Cost Ratio	Net Benefit
Plan A	3-1/4	729,000	253,000	2.88	476,000
Plan B	3-1/4	772,000	261,000	2.96	511,000
Plan C	3-1/4	1,004,000	355,000	2.83	649,000
Plan A	7-5/8	666,000	474,000	1.41	192,000
Plan B	7-5/8	721,000	490,000	1.47	231,000
Plan C	7-5/8	854,000	665,000	1.28	189,000

F. Apportionment of Costs Among Interests

Costs for the improvement under consideration have been apportioned between the United States and local interests so that the Federal and non-Federal share of the first cost of construction are in the same ratio as the evaluated general and local benefits. The first cost of construction of the breakwaters and Federal and non-Federal investments resulting from this apportionment are shown in Table XIV.

TABLE XIV
Apportionment of Costs

	3-1/4%	7-5/8%
Plan A		
Federal Investment		
Corps of Engineers		
Project Construction		
61% x $5,893,000	$3,594,780	$ 0
62% x $5,893,000	0	3,653,600
U.S. Coast Guard		
Navigation Aids	6,000	6,000
TOTAL FEDERAL INVESTMENT	$3,600,780	$3,659,660
Non-Federal Investment		
Cash Contributed for Project Constr.		
39% x $5,893,000	2,298,220	0
38% x $5,893,000	0	2,239,340
TOTAL NON-FEDERAL INVESTMENT	$2,298,220	$2,239,340
TOTAL INVESTMENT	$5,899,000	$5,899,000

TABLE XIV (Cont.)

Apportionment of Costs

	3-1/4%	7-5/8%
Plan B		
Federal Investment		
Corps of Engineers		
Project Construction		
65% x $6,084,500	$3,954,925	$ 0
66% x $6,084,500	0	4,015,770
U.S. Coast Guard		
Navigation Aids	6,500	6,500
TOTAL FEDERAL INVESTMENT	$3,961,425	$4,022,270
Non-Federal Investment		
Cash Contributed for Project Constr.		
35% x $6,084,500	2,129,575	0
34% x $6,084,500	0	2,068,730
TOTAL NON-FEDERAL INVESTMENT	$2,129,575	$2,068,730
TOTAL INVESTMENT	$6,091,000	$6,091,000
Plan C		
Federal Investment		
Corps of Engineers		
Project Construction		
62% x $8,253,500	$5,117,700	$ 0
64% x $8,253,500	0	5,282,240
U.S. Coast Guard		
Navigation Aids	9,500	9,500
TOTAL FEDERAL INVESTMENT	$5,126,670	$5,291,740
Non-Federal Investment		
Cash Contributed for Project Constr.		
38% x $8,253,500	3,136,330	0
36% x $8,253,500	0	2,971,260
TOTAL NON-FEDERAL INVESTMENT	$3,136,330	$2,971,260
TOTAL INVESTMENT	$8,263,000	$8,263,000

The apportionment of costs in the Authorizng Document in August 1968, mandated the percentages at 64% Federal and 36% local, therefore, the breakdown of Federal/local costs for the selected plan (Plan B) would be as shown in Table XV.

TABLE XV
Apportionment of Costs for the Selected Plan

Selected Plan (Plan B)	3-1/4
Federal Investment	
Corps of Engineers	
Project Construction	
64% x $6,084,500	$3,894,500
U.S. Coast Guard	
Navigational Aids	6,500
TOTAL FEDERAL INVESTMENT	$3,901,000
Non-Federal Investment	
Cash Contribution for Project Construction	
36% x $6,084,500	$2,190,000
TOTAL NON-FEDERAL INVESTMENT	$2,190,000
TOTAL INVESTMENT	$6,091,000

Bristol Harbor is not mentioned in the 1980 University of Rhode Island report Commercial Fishing Facilities Needs in Rhode Island. The ports discussed include Galilec, Newport, Coddington Cove, Melville, Quonset Point, Davisville and Sakonnet Point. Bristol Harbor is located about 5 miles further from the fishing grounds than Melville. The report comments that "Melville's position almost halfway up the bay is a drawback to fishermen especially day trip and short trip fishermen who are becoming ever more conscious of the strain that increased fuel costs and extra steaming time places on their earnings."

It is felt that Bristol per se is not the critical element in establishing a hake fishery. There are several ports which could accommodate all or some of the harvesting vessels, (e.g. Provincetown, Boston, Newport, Gloucester, etc.).

BENEFIT ANALYSIS OF SSP PROPOSAL

a. Assumptions From SSP Proposal

- 12 harvesting vessels

- Maximum processing capacity of processing vessels is about 88,000 lb.
(40 metric tons x 2204.6 lb/metric ton)

- Average selling price is 12 cents per lb
(Proposal assumes range of 8 - 16 cents)

- Each vessel will make 35 trips of 4 days each which gives 140 days of fishing each year.

b. Additional Assumptions From NED

- Maximum of 8 month fishery
(Gulf shrimp boats cannot fish offshore in winter)

- 50 percent chance(1) that the proposal for the joint venture would be implemented.
(Substantial uncertainty due to bureaucratic and political considerations)

- 75 percent chance(1) that the joint venture agreement would be renewed for each additional year for the remainder of a 10 year period.
(A joint venture is essentially an agreement with a 1 year term.) Following the issuance of the initial permit it is thought that renewals are more likely but by no means certain.

- No chance that the joint venture agreement will be renewed after 10 years.
(Joint venture arrangements are meant to be temporary arrangements only. They are meant to take up the slack until the US fishing industry is capable of harvesting, processing and marketing the entire fishable resource within the 200 mile Fishery Conservation Zone.

c. Benefit Computation

If the joint venture is implemented the annual catch would have an average value of about $1.5 million.

(88,000 lbs/day x 140 fishing days/yr x $0.12/lb)

(1) Personal communications with National Marine Fisheries personnel in Gloucester, Massachusetts, responsible for reviewing and licensing Joint Venture Agreements.